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am the translator of the document attached and I state that the following is a true translation to the best of my knowledge and belief of Japanese Patent Application No. 2000-207001 (Date of Application: 7 July 2000).

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OPTICAL PICK-UP, OPTICAL DISK APPARATUS AND INFORMATION PROCESSING APPARATUS

[CLAIMS]

[Claim 1] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photo detecting portion comprises a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram, and wherein a distance d1 between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[Claim 2] The optical pick-up according to claim 1, wherein the hologram is a phase-type hologram.

[Claim 3] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical

disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photo detecting portion comprises a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram, and a distance d1 between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source, and a distance d12 between the light emitting spots of the first and second semiconductor laser light sources satisfy the following relationship:

$d2 = d1 + d12$,

$d1 \fallingdotseq \lambda1 \cdot d12/(\lambda2 - \lambda1)$, and

$d2 \fallingdotseq \lambda2 \cdot d12/(\lambda2 - \lambda1)$.

[Claim 4] The optical pick-up according to any one of claims 1 to 3, wherein the photo detecting portion PD0 is divided into a plurality of regions, and output from the regions are calculated to detect a tracking error signal.

[Claim 5] The optical pick-up according to any one of claims 1 to 4, wherein the output from the photo detecting portion PD0 are calculated to detect an information signal.

[Claim 6] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength λ1;

a second semiconductor laser light source for emitting a light beam with wavelength λ2;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photodetector comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and

wherein when information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[Claim 7] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photodetector comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram; and a distance d1 between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[Claim 8] The optical pick-up according to claim 7, wherein when d12 denotes a distance between the light emitting spot of the first semiconductor laser light source and the light emitting spot of the second semiconductor laser light source, a gap between the center of the photo detecting portion PD1 and the center of the photo detecting portion PD2 is set to be about twice d12.

[Claim 9] The optical pick-up according to claim 7 or 8, wherein the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and when information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[Claim 10] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photodetector comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram; a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram; and a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram.

[Claim 11] An optical pick-up comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$;

a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk;

a hologram for diffracting the light beam reflected by the optical disk; and

a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light,

wherein the photo detecting portion comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram; a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram; and a photo detecting portion PD0 for receiving a +first order diffracted light diffracted by the hologram, and

wherein when a distance between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source is d1, a distance between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source is d2, and a distance between the light emitting spots of the first and second semiconductor laser light sources is d12,

a distance between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source is d1, and a distance between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source is d2, and the following relationships are satisfied:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$,

$d2 = d1 + d12$,

$d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 2 - \lambda 1)$, and

$d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 2 - \lambda 1)$.

[Claim 12] An optical pick-up, wherein a photo detecting portion PD1, a photo detecting portion PD2 and a photo detecting portion PD0 are divided

into a plurality of regions respectively, and when information reproduction is carried out by using light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal; when information reproduction is carried out by using light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal; and signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a tracking error signal.

[Claim 13] The optical pick-up according to any one of claims 1 to 12, wherein the first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$ and the second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$ are formed monolithically on one semiconductor chip.

[Claim 14] The optical pick-up according to any one of claims 1 to 13, comprising a grating that forms a main beam and sub-beams that are ±first order diffracted light by receiving a light beam with wavelength $\lambda 2$ emitted from the second semiconductor laser light source when the wavelength $\lambda 1$ is set to be 610 nm to 670 nm, and the wavelength $\lambda 2$ is set to be 740 nm to 830 nm,

wherein a grating cross-sectional shape of the grating is substantially rectangular, the width of a concave portion and the width of a convex portion are substantially the same, and the level difference h between the concave portion and the convex portion of the cross sectional shape is represented by the following relationship when n1 denotes a refractive index of a material of the grating with respect to the wavelength $\lambda 1$:

$h = \lambda 1/(n1 - 1)$, and

the level difference in an optical path between the concave portion and the convex portion is set to be one wavelength.

[Claim 15] The optical pick-up according to claim 14, wherein in both of the light beam with wavelength $\lambda 1$ and the light beam with wavelength $\lambda 2$, a light beam entering an objective lens without being diffracted by the grating forms grating stripes in the entire range satisfying NA necessary to the reproduction of the optical disk.

[Claim 16] The optical pick-up according to any one of claims 1 to 15, wherein the light emitting spot of the first semiconductor laser light source is arranged substantially on the optical axis of the converging optical

system.

[Claim 17] The optical pick-up according to any one of claims 6 to 16, wherein the photo detecting portion comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength λ1 in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength λ2 in the diffracted light diffracted by the hologram,

wherein the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and when information reproduction is carried out by the use of the light with wavelength λ1, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength λ2, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal, and

wherein the shape of the photo detecting portion PD1 is different from the shape of the photo detecting portion PD2.

[Claim 18] The optical pick-up according to any one of claims 6 to 17, wherein the photo detecting portion comprises a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength λ1 in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength λ2 in the diffracted light diffracted by the hologram, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions by dividing lines,

wherein when information reproduction is carried out by using light with wavelength λ1, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal; when information reproduction is carried out by using light with wavelength λ2, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal, and

wherein a symmetrical central line parallel to the dividing line of the photo detecting portion PD2 and a symmetrical central line parallel to the dividing line of the photo detecting portion PD1 are deviated from each other in the direction perpendicular to each symmetrical central line.

[Claim 19] An optical disk apparatus comprising an optical pick-up according to any one of claims 1 to 18 having a focus control means with

respect to an optical disk, a tracking control means and an information signal detection means; a moving mechanism for the optical pick-up; and a rotation mechanism for rotating the optical disk.

[Claim 20] An optical disk type recognition method for determining whether an optical disk is present in the optical disk apparatus, and determining whether a disk that is present is CD or DVD, the method comprising:

by using an optical disk apparatus provided with an optical pick-up using an infrared light source and a red light source, determining whether an optical disk is present by allowing the infrared light source to emit light first to use the emitted infrared light beam when the power of the optical disk apparatus is turned on, or when an optical disk is newly inserted into the apparatus; and

determining the kinds of the optical disk by using the reflected light from the optical disk when the optical disk is present.

[Claim 21] An optical disk recording and reproducing method, comprising:

recording or reproducing information by continuing to allow the infrared light to be emitted when the inserted optical disk is judged to be CD by the determination of the optical disk by the use of the optical disk type recognition method according to claim 20; and

recording or reproducing information on DVD by extinguishing the infrared light and turning on the red light when the inserted disk is judged to be DVD by the determination of the optical disk by the use of the optical disk type recognition method according to 20.

[Claim 22] An information processing apparatus, comprising:

an optical disk apparatus for recording or reproducing information on an optical disk, or for recording and for reproducing information on an optical disk; and

an image information read-out means for reading out an image information on a manuscript,

wherein the image information read out can be recorded on the optical disk apparatus.

[Claim 23] An information processing apparatus, comprising:

an optical disk apparatus for recording or reproducing information on an optical disk, or for recording and for reproducing information on an optical disk;

an image information read-out means for reading out an image

information on a manuscript;

a means for feeding manuscript sheet;

an information copying means; and

a finished paper receiving holder for holding finished paper,

wherein the image information read out can be recorded on the optical disk apparatus, and the image information read out can be copied by the copying means or the image information recorded on the optical disk apparatus can be copied by the copying means.

[Claim 24] An image projection apparatus, comprising:

a front glass of a car; and

a projecting means for projecting an image onto the front glass.

[Claim 25] An image projection apparatus, comprising:

a front glass of a car;

a projecting means for projecting an image onto the front glass; and

an optical disk apparatus for recording or reproducing information on the optical disk, or an optical disk apparatus for recording and reproducing information,

wherein the information reproduced from the optical disk apparatus is projected onto the front glass.

[Claim 26] The image projecting apparatus according to claim 25, comprising a converting circuit for converting the information reproduced by the optical disk apparatus into an image adjusted to the curvature of the front glass, wherein the information output from the converting circuit is projected onto the front glass.

[Claim 27] A semiconductor laser apparatus, comprising:

a first semiconductor laser light source for emitting a light beam with wavelength λ1;

a second semiconductor laser light source for emitting a light beam with wavelength λ2; and

a photodetector formed of a photo detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light,

wherein a distance d1 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the second semiconductor laser light

source satisfy the following relationship:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[Claim 28] A semiconductor laser apparatus, comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and

a photodetector formed of a photo detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light,

wherein a distance d1 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the first semiconductor laser light source, a distance d2 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the second semiconductor laser light source, and a distance d12 between the light emitting spots of the first and second semiconductor laser light sources satisfy the following relationships:

$d2 = d1 + d12$,

$d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 2 - \lambda 1)$, and

$d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 2 - \lambda 1)$.

[Claim 29] A semiconductor laser apparatus, comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and

a photodetector formed of a photo detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light,

wherein the photodetector comprises a photo detecting portion PD1 for receiving the light with wavelength $\lambda 1$, and a photo detecting portion PD2 for receiving the light with wavelength $\lambda 2$; and a distance d1 between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[Claim 30] The semiconductor laser apparatus according to claim 29,

wherein at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into five strip-shaped regions.

[Claim 31] The semiconductor laser apparatus according to claim 29, wherein at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into four strip-shaped regions.

[Claim 32] The semiconductor laser apparatus according to claim 29, wherein at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into six strip-shaped regions.

[Claim 33] A semiconductor laser apparatus, comprising:

a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$;

a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and

a photodetector formed of a photo detecting portion for receiving the light and for outputting an electric signal proportional to the amount of the light,

wherein the photodetector comprises a photo detecting portion PD1 for receiving a light beam with wavelength $\lambda 1$, a photo detecting portion PD2 for receiving a light beam with wavelength $\lambda 2$, and a photo detecting portion PD0 for receiving both lights with wavelength $\lambda 1$ and wavelength $\lambda 2$,

wherein when a distance between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source is d1, a distance between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source is d2, and a distance between the light emitting spots of the first and second semiconductor laser light sources is d12,

a distance between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source is d1, and a distance between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source is d2, and the following relationships are satisfied:

$\lambda 1/\lambda 2 \fallingdotseq d1/d2$,

$d2 = d1 + d12$,

$d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 1 - \lambda 2)$, and

$d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 1 - \lambda 2)$.

[Claim 34] The semiconductor laser apparatus according to any one of

claims 27 to 33, wherein the first semiconductor laser light source and the second semiconductor laser light source are formed monolithically on one semiconductor chip.

[Claim 35] The semiconductor laser apparatus according to any one of claims 27 to 34, wherein the photo detecting portion comprises a photo detecting portion PD1 for receiving light with wavelength λ1 and a photo detecting portion PD2 for receiving light with wavelength λ2, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and the shape of the photo detecting portion PD1 is different from the shape of the photo detecting portion PD2.

[Claim 36] The semiconductor laser apparatus according to any one of claims 27 to 35, wherein the photo detecting portion comprises a photo detecting portion PD1 for receiving the light with wavelength λ1 and a photo detecting portion PD2 for receiving the light with λ2, and

wherein the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and a symmetrical central line parallel to the dividing line of the photo detecting portion PD2 and a symmetrical central line parallel to the dividing line of the photo detecting portion PD1 are deviated from each other in the direction perpendicular to each symmetrical central line.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical field to which the invention pertains]

The present invention relates to an optical pick-up used for recording/ reproducing or erasing information on an optical disk, an optical disk apparatus, and an information processing apparatus using the same.

[0002]

[Prior Art]

Optical memory technology that uses optical disks having a pit pattern as high-density, large-capacity information storage media has been expanding its application from digital audio disks to video disks, document file disks, and further to data files, etc. In recent years, a high-density optical disk such as DVD-ROM etc. using a visible red laser of wavelength of 630 nm to 670 nm as a light source has become prevalent. Furthermore, an optical disk (DVD-RAM) capable of high density recording has been commercialized. A large capacity of digital data has been able to be recorded on an optical disk easily. Furthermore, CD-R that is highly

compatible with CD, which has been used broadly, has been prevalent.
[0003]

From the above mentioned background, in the information reproducing apparatus using DVD, in addition to DVD-ROM and CD, the reproduction on DVD-RAM and CD-R is important. In the information recording and reproducing apparatus using DVD, in addition to the recording and reproducing function on DVD-RAM, the reproduction on DVD-ROM, CD and CD-R is important.
[0004]

Since recording/reproducing information on CD-R is carried out by the use of the change in the reflectance of light colors and is optimized to a wavelength of about 800 nm, in other wavelengths of light such as visible light, signals may not be reproduced. Therefore, in order to reproduce information on CD-R, it is desirable that an infrared light source having a wavelength of about 800 nm is used. The optical pick-up provided with a red semiconductor laser for DVD and an infrared semiconductor laser for CD and CD-R has been developed. For simplifying the optical system so as to realize miniaturization and low cost, it is proposed that the above-mentioned two kinds of semiconductor lasers, each having a different wavelength, are integrated into one package.
[0005]

Referring to Figures 19 and 20, an optical pick-up disclosed in JP 10 (1998)-289468 A will be described. Figure 19 is a schematic view showing a configuration of an optical pick-up 200. In formation recording/reproduction is performed on an optical disk 7. There are a plurality of optical disks having a transparent substrate 220 with different thickness. Recording/reproduction herein denotes recording information on an information recording surface 240 of the optical disk 7 or reproducing information on the information recording surface 240. A conventional optical pick-up apparatus 200 has a first semiconductor laser 100a (wavelength λ = 610 nm to 670 nm) as a first light source and a second semiconductor laser 100b (wavelength λ = 740 nm to 830 nm) as a second light source. This first semiconductor laser 100a is a light source used for recording/reproducing information on DVD and the semiconductor laser 100b is a light source used for recording/reproducing information on the second optical disk. These semiconductor lasers are used depending upon the kinds of optical disks on which recording/reproducing is performed.

[0006]

A synthesizer 210 synthesizes a light flux emitted from the first semiconductor laser 100a and a light flux emitted from the second semiconductor laser 100b into one identical optical path (which may be substantially the same optical path) to converge the synthesized light flux onto the optical disk 7 via a converging optical system mentioned below. By using a polarizing prism (a birefringent plate) as the synthesizer 210, the light flux emitted from the first semiconductor laser 100a is allowed to pass through the optical path without changing the optical path as an ordinary ray, and the light flux emitted from the second semiconductor laser 100b is allowed to change the optical path as an abnormal ray. This synthesizer 210 may be a hologram.

[0007]

The optical converging system including an objective lens 60 and a collimating lens 50 is a means for converging a light flux emitted from the semiconductor laser and forming a light spot on the information recording surface 240 via the transparent substrate 220 of the optical disk 7. An aperture stop 150 limits the light flux to the predetermined number of apertures.

[0008]

A unit 160 includes a hologram 40 and a photodetector 800, etc. in addition to the first semiconductor laser 100a and the second semiconductor laser 100b, which is shown in detail in Figure 21. In the unit 160, the first semiconductor laser 100a, the second semiconductor laser 100b and the photodetector 800 are arranged in one plane. A further photodetector 230 is arranged for detecting the light from the semiconductor laser rear part. This photodetector 230 is used for current control of the semiconductor laser with an APC (auto power control) circuit based on the amount of light emitted from a rear part of the semiconductor laser.

[0009]

Furthermore, in this configuration, a focus error signal is detected by a knife edge method. Therefore, on a photo-receiving surface of the photo detector 800, eight photo receiving elements (photo receiving surfaces), A1-D1, A2-D2 are provided. Furthermore, as a photo diverging means, the hologram 40 is used. This hologram element is divided into four parts such as A to D, and the hologram is arranged so that the light beams passing through the divided surfaces are focused on the photo receiving surface of

the photo detecting means 800.

[0010]

Similarly, for the purpose of achieving the small size optical pick up capable of recording/reproducing information on DVD, CD, CD-R, a configuration in which a photo detector and two semiconductor laser chips each having different wavelength are integrated into one unit is disclosed in JP10 (1998)-319318 A, JP 10 (1998)-21577 A, JP 10 (1998)-64107 A, JP 10 (1998)-321961 A, JP 10 (1998)-289468 A, JP 10 (1998)-134388 A, JP10 (1998)-149559 A, JP10 (1998)-241189 A, etc.

[0011]

[Problem to be solved by the invention]

The category of DVD includes DVD-RAM, in addition to DVD-ROM. Therefore, it is desirable that recording or reproducing apparatus by the use of DVD can reproduce information on DVD-ROM, DVD-RAM, CD-ROM, and CD-R (CD-RECORDABLE), the latter two of which have been prevalent. Each of these disks has respective standardizations, and the standardization defines respective tracking error (TE) signal detection methods capable of reproducing information stably.

[0012]

A TE signal of the DVD-ROM can be obtained by the phase difference detection method. The phase difference detection method also is referred to as a differential phase detection (DPD) method. By using the change in the strength of far field pattern (FFP) returning from the optical disk by reflection/diffraction, the TE signal can be obtained with one beam. The method uses a change of the diffracted light by the two-dimensional arrangement of pits. The change of the distribution of the light amount in the diffraction by pit rows is detected by the 4-divided photodetector to compare the phases, thereby obtaining the TE signal. This method is suitable for a reproduction only disk having pit rows.

[0013]

A TE signal of the DVD-RAM can be obtained by a push-pull (PP) method. The PP method is used mainly for a rewritable optical disk and a write once type optical disk. When the guide groove of the optical disk recording surface of the optical disk is irradiated with a converged light spot, the reflected light accompanies a diffracted light in the direction in which the guide groove extends and the direction perpendicular to the guide groove. The FFP returning to surface of the objective lens has an optical intensity

distribution due to the interference of the ±first order diffracted light and zero order diffracted light in the guide groove. Depending upon the positional relationship between the guide grooves and the converging spot, one part of the FFP becomes bright and another part of the FFP becomes dark, or on the contrary, one part of the FFP becomes dark and another part of the FFP becomes bright. TE signals can be obtained by the PP method by detecting the change in the optical intensity by using the 2-divided photodetector.

[0014]

In both the CD-ROM (which includes CD for audio) and CD-R, TE signals can be obtained by the PP method from the viewpoint of standard. However, as compared with DVD-RAM, the strength of TE signals is weak. Furthermore, the PP method has a problem in that a TE signal offset occurs due to the lens shift. In DVD-RAM, in order to avoid such a problem, an offset compensation zone for TE signals is provided on a part of the information recording surface. However, there is no means for solving the problem of offset in the case of CD-ROM or CD-R. Therefore, as the TE signal detection method, usually a 3-beam method is used in CD-ROM or CD-R.

[0015]

In the 3-beam method, the grating is inserted into the outward path from a light source to an optical disk and zero order diffracted beam (main beam) and ±first diffracted light beams (sub-beams) of the grating are formed on the optical disk. When the main beam is deviated from the center of the track, one of the sub-beams approaches to the center of the track and the other sub-beam is distant from the center of the track, thus causing the difference in the amount of reflected return light. By detecting this difference, TE signals can be obtained.

[0016]

As mentioned above, for recording or reproducing information on DVD-ROM, DVD-RAM, and CD-ROM, CD-R, it is necessary to carry out three kinds of methods, i.e., the phase difference method, PP method, 3-beam method. However, in conventional methods, there is no specific example of the configuration capable of corresponding to three types of TE signals detection methods, i.e. the phase difference method, PP method, and 3-beam method.

[0017]

Furthermore, DVD and CD have different thickness of transparent substrates covering the information recording surface. The standard substrate thickness of DVD is 0.6 mm and the standard substrate thickness of CD is 1.2 mm. By converging light by the use of the common optical converging system common in the optical disk having substrates each having different thickness, a spherical aberration that is an aberration symmetrical with respect to the optical axis, occurs. A large number of methods for recording/reproducing information on DVD and CD by the use of a common light converging system are proposed. Furthermore, DVD has a higher recording density than CD, and even if the red laser light source with a short wavelength is used, the necessary numeral aperture (NA) of the lens is 0.6, which is larger than the NA for CD (0.45). A conventional method such as JP10 (1998)-289468 A discloses a configuration in which the NA is reduced as compared with the NA when reproducing information on CD by using the aperture stop 150.

[0018]

As mentioned above, information reproduction on CD and DVD are carried out under the remarkably different optical conditions of thickness of substrate, wavelength of light source and NA. Therefore, like in a conventional method, when reproducing information on CD and DVD, in a configuration in which FE signals are detected from the common photo-receiving dividing regions, due to the difference in the optical properties such as the above-mentioned items, the deterioration of properties, for example, FE signal offset, deterioration of FE signal amplitude (signal strength) and the like, occur.

[0019]

Furthermore, a configuration suitable for obtaining the excellent signal when reproducing information on DVD and CD, considering a difference in the wavelength and the position of the light emitting spots has not conventionally been considered.

[0020]

[Means for solving problem]

In order to reproduce (and record) information using DVD-ROM, DVD-RAM, CD and CD-R, the optical pick-up of the present invention is provided with two light sources of a red LD and an infrared LD, and the two light sources and a photodetector are integrated into the same package. Furthermore, the present invention has the following characteristics.

[0021]

(1) A grating for receiving light emitted from an LD and dividing the light into a main beam and sub-beams diffracts only infrared light, thus preventing diffraction of red light from occurring.

[0022]

(2) A focus error signal is detected from a −first-order diffracted light from a hologram, and a TE signal is detected from a +first-order diffracted light.

[0023]

(3) In the optical pick-up in which laser light sources having two kinds of wavelengths ($\lambda 1$, $\lambda 2$) for detecting TE signals, a photodetector, and a hologram are integrated, a distance d1 between the center of a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram and the light emitting spot of the first laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[0024]

(4) The photo detecting portion PD0 is divided into a plurality of regions, and output from the regions are calculated to detect a tracking error signal.

[0025]

(5) A photo detecting portion PD1 for receiving a −first order diffracted light of the light with wavelength $\lambda 1$ and a photo detecting portion PD2 for receiving a −first order diffracted light of the light with wavelength $\lambda 2$ are provided. The photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively. When information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the divided regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the divided regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0026]

Specific configurations of the present invention provided with the above-mentioned characteristics are as follows.

[0027]

[1] A first basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light. The photo detecting portion includes a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram, and a distance d1 between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[0028]

Herein, the hologram is referred to as an optical element in which a phase or a transmissivity has a periodical structure. (The period or direction, that is, a grating vector, may vary depending on the parts.) In the present invention, the hologram is used as a diffractive element having a function of diffracting the light beams reflected by the optical disk.

[0029]

[2] In the above-mentioned configuration, the hologram may be a phase-type hologram.

[0030]

[3] A second basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of

the diffracted light. The photo detecting portion includes a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram, and a distance d1 between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source, and a distance d12 between the light emitting spots of the first and second semiconductor laser light sources satisfy the following relationship: $d2 = d1 + d12$, $d1 \fallingdotseq \lambda1 \cdot d12/(\lambda2 - \lambda1)$, and $d2 \fallingdotseq \lambda2 \cdot d12/(\lambda2 - \lambda1)$.

[0031]

[4] In the optical pick-up of any one of the above-mentioned configurations, preferably, the photo detecting portion PD0 is divided into a plurality of regions, and output from the regions are calculated to detect a tracking error signal.

[0032]

[5] Furthermore, the output from the photo detecting portion PD0 may be calculated to detect an information signal.

[0033]

[6] A third basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength λ1; a second semiconductor laser light source for emitting a light beam with wavelength λ2; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light. The photodetector includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength λ1 in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength λ2 in the diffracted light diffracted by the hologram. The photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and when information reproduction is carried out by the use of the light with wavelength λ1, signals obtained from the regions of the photo detecting portion PD1 are

calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength λ2, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0034]

[7] A fourth basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength λ1; a second semiconductor laser light source for emitting a light beam with wavelength λ2; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light. The photodetector includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength λ1 in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength λ2 in the diffracted light diffracted by the hologram. A distance d1 between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship: $\lambda1/\lambda2 \fallingdotseq d1/d2$.

[0035]

[8] In this configuration, preferably, when d12 denotes a distance between the light emitting spot of the first semiconductor laser light source and the light emitting spot of the second semiconductor laser light source, a gap between the center of the photo detecting portion PD1 and the center of the photo detecting portion PD2 is set to be about twice d12.

[0036]

[9] In the above-mentioned configuration [7] or [8], more preferably, the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and when information reproduction is carried out by the use of the light with wavelength λ1, signals obtained from the regions of the photo detecting portion PD1 are

calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0037]

In this configuration, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 may be divided into five strip-shaped regions. In the configuration, two of the five strip-shaped regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector.

[0038]

Alternatively, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 may be divided into four regions. In the configuration, two of the divided regions may be connected in the photodetector, and further the remaining two regions also may be connected in the photodetector.

[0039]

Alternately, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 may be divided into six regions. In the configuration, two of the divided regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector. Furthermore, a focus error signal may be detected from outputs of the two connected regions, and a tracking error signal may be detected from outputs of the remaining two connected regions.

[0040]

[10] A fifth basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light. The photodetector includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with

wavelength $\lambda 1$ in the diffracted light diffracted by the hologram; a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram; and a photo detecting portion PD0 for receiving a +first order diffracted light from the hologram.

[0041]

[11] A sixth basic configuration of the optical pick-up of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; a converging optical system for receiving the light beams emitted from the first and second semiconductor laser light sources and for converging the received light beams into a microscopic spot on an optical disk; a hologram for diffracting the light beam reflected by the optical disk; and a photodetector formed of a photo detecting portion for receiving the diffracted light diffracted by the hologram and for outputting an electric signal proportional to the amount of the diffracted light. The photo detecting portion includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram; a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram; and a photo detecting portion PD0 for receiving a +first order diffracted light diffracted by the hologram. When a distance between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source is d1, a distance between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source is d2, and a distance between the light emitting spots of the first and second semiconductor laser light sources is d12, a distance between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source is d1, and a distance between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source is d2, and the following relationships are satisfied: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$, $d2 = d1 + d12$, $d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 2 - \lambda 1)$, and $d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 2 - \lambda 1)$.

[0042]

[12] In a seventh basic configuration of the optical pick-up of the present invention, a photo detecting portion PD1, a photo detecting portion

PD2 and a photo detecting portion PD0 may be divided into a plurality of regions respectively, and when information reproduction is carried out by using light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 may be calculated to detect a focus error signal; when information reproduction is carried out by using light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 may be calculated to detect a focus error signal; and signals obtained from the regions of the photo detecting portion PD1 may be calculated to detect a tracking error signal.

[0043]

In this configuration, output from the photo detecting portion PD0 further may be calculated to detect an information signal.

[0044]

[13] In the optical pick-up of any one of the above-mentioned configurations, the first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$ and the second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$ may be formed monolithically on one semiconductor chip.

[0045]

[14] The optical pick-up of any one of the above-mentioned configurations preferably includes a grating that forms a main beam and sub-beams that are ±first order diffracted light by receiving a light beam with wavelength $\lambda 2$ emitted from the second semiconductor laser light source when the wavelength $\lambda 1$ is set to be 610 nm to 670 nm, and the wavelength $\lambda 2$ is set to be 740 nm to 830 nm. A grating cross-sectional shape of the grating is substantially rectangular, and the width of a concave portion and the width of a convex portion are substantially the same. The level difference h between the concave portion and the convex portion of the cross sectional shape is represented by the following relationship when n1 denotes a refractive index of a material of the grating with respect to the wavelength $\lambda 1$: $h = \lambda 1/(n1 - 1)$, and the level difference in an optical path between the concave portion and the convex portion is set to be one wavelength.

[0046]

[15] In this configuration, in both of the light beam with wavelength $\lambda 1$ and the light beam with wavelength $\lambda 2$, a light beam entering an objective lens without being diffracted by the grating forms grating stripes

in the entire range satisfying NA necessary to the reproduction of the optical disk.

[0047]

[16] In the optical pick-up of any one of the above-mentioned configurations, preferably, the light emitting spot of the first semiconductor laser light source is arranged substantially on the optical axis of the converging optical system.

[0048]

[17] In the optical pick-up of any one of the above-mentioned configurations, preferably, the photo detecting portion includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively. When information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal. The shape of the photo detecting portion PD1 is different from the shape of the photo detecting portion PD2.

[0049]

[18] In the optical pick-up of any one of the above-mentioned configurations, preferably, the photo detecting portion includes a photo detecting portion PD1 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 1$ in the diffracted light diffracted by the hologram, and a photo detecting portion PD2 for receiving a −first order diffracted light of the light beam with wavelength $\lambda 2$ in the diffracted light diffracted by the hologram, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions by dividing lines. When information reproduction is carried out by using light with wavelength $\lambda 1$, signals obtained from the regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when information reproduction is carried out by using light with wavelength $\lambda 2$,

signals obtained from the regions of the photo detecting portion PD2 are calculated to detect a focus error signal. A symmetrical central line parallel to the dividing line of the photo detecting portion PD2 and a symmetrical central line parallel to the dividing line of the photo detecting portion PD1 are deviated from each other in the direction perpendicular to each symmetrical central line.

[0050]

[19] An optical disk apparatus of the present invention includes: an optical pick-up of any one of the above-mentioned configurations having a focus control means with respect to an optical disk, a tracking control means and an information signal detection means; a moving mechanism for the optical pick-up; and a rotation mechanism for rotating the optical disk.

[0051]

[20] The optical disk type recognition of the present invention is a method for determining whether an optical disk is present in the optical disk apparatus, and determining whether a disk that is present is CD or DVD, the method using an optical disk apparatus provided with an optical pick-up using an infrared light source and a red light source. The method includes: determining whether an optical disk is present by allowing the infrared light source to emit light first to use the emitted infrared light beam when the power of the optical disk apparatus is turned on, or when an optical disk is newly inserted into the apparatus; and determining the kinds of the optical disk by using the reflected light from the optical disk when the optical disk is present.

[0052]

[21] An optical disk recording and reproducing method of the present invention includes: recording or reproducing information by continuing to allow the infrared light to be emitted when the inserted optical disk is judged to be CD by the determination of the optical disk by the use of the above-mentioned optical disk type recognition method; and recording or reproducing information on DVD by extinguishing the infrared light and turning on the red light when the inserted disk is judged to be DVD by the determination of the optical disk by the use of the above-mentioned optical disk type recognition method.

[0053]

[22] An information processing apparatus of the present invention includes: an optical disk apparatus for recording or reproducing information

on an optical disk, or for recording and for reproducing information on an optical disk; and an image information read-out means for reading out an image information on a manuscript, wherein the image information read out can be recorded on the optical disk apparatus.

[0054]

[23] An information processing apparatus of the present invention includes: an optical disk apparatus for recording or reproducing information on an optical disk, or for recording and for reproducing information on an optical disk; an image information read-out means for reading out an image information on a manuscript; a means for feeding manuscript sheet; an information copying means; and a finished paper receiving holder for holding finished paper. The image information read out can be recorded on the optical disk apparatus, and the image information read out can be copied by the copying means or the image information recorded on the optical disk apparatus can be copied by the copying means.

[0055]

[24] An image projection apparatus of the present invention includes: a front glass of a car; and a projecting means for projecting an image onto the front glass.

[0056]

[25] An image projection apparatus of the present invention includes: a front glass of a car; a projecting means for projecting an image onto the front glass; and an optical disk apparatus for recording or reproducing information on the optical disk, or an optical disk apparatus for recording and reproducing information, wherein the information reproduced from the optical disk apparatus is projected onto the front glass.

[0057]

[26] The image projection apparatus of this configuration may include a converting circuit for converting the information reproduced by the optical disk apparatus into an image adjusted to the curvature of the front glass, wherein the information output from the converting circuit is projected onto the front glass.

[0058]

[27] A semiconductor laser apparatus of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and a photodetector formed of a photo

detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light. A distance d1 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the second semiconductor laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[0059]

In the semiconductor laser apparatus of this configuration, the photo detecting portion PD0 may be divided into a plurality of regions, and output from the regions may be calculated to detect a tracking error signal. Furthermore, the output from the photo detecting portion PD0 may be calculated to detect an information signal.

[0060]

[28] Another semiconductor laser apparatus of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and a photodetector formed of a photo detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light. A distance d1 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the first semiconductor laser light source, a distance d2 between the center of the photo detecting portion PD0 included in the photo detecting portion and the light emitting spot of the second semiconductor laser light source, and a distance d12 between the light emitting spots of the first and second semiconductor laser light sources satisfy the following relationships: $d2 = d1 + d12$, $d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 2 - \lambda 1)$, and $d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 2 - \lambda 1)$.

[0061]

In this configuration, the photo detecting portion PD0 may be divided into a plurality of regions, and output from the regions may be calculated to detect a tracking error signal. Furthermore, the output from the photo detecting portion PD0 may be calculated to detect an information signal.

[0062]

[29] Another semiconductor laser apparatus of the present invention

includes: a first semiconductor laser light source for emitting a light beam with wavelength λ1; a second semiconductor laser light source for emitting a light beam with wavelength λ2; and a photodetector formed of a photo detecting portion for receiving the light beam and for outputting an electric signal proportional to the amount of the light, wherein the photodetector includes a photo detecting portion PD1 for receiving the light with wavelength λ1, and a photo detecting portion PD2 for receiving the light with wavelength λ2. A distance d1 between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[0063]

In this configuration, preferably, when d12 denotes a distance between the light emitting spot of the first semiconductor laser light source and the light emitting spot of the second semiconductor laser light source, a gap between the center of the photo detecting portion PD1 and the center of the photo detecting portion PD2 is set to be about twice d12.

[0064]

Further, preferably, the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of photo detecting portions respectively, and when information reproduction is carried out by the use of the light with wavelength λ1, signals obtained from the divided regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength λ2, signals obtained from the divided regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0065]

[30] In the semiconductor laser apparatus of this configuration, preferably, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into five strip-shaped regions. In the configuration, two of the five strip-shaped regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector.

[0066]

[31] Further, preferably, at least one of the photo detecting portion

PD1 and the photo detecting portion PD2 is divided into four strip-shaped regions. In the configuration, two of the four strip-shaped regions may be connected in the photodetector, and further the remaining two regions also may be connected in the photodetector.

[0067]

[32] Further, preferably, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into six strip-shaped regions. In the configuration, two of the six strip-shaped regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector. Furthermore, in the configuration, a focus error signal may be detected from outputs of the two connected regions, and a tracking error signal may be detected from outputs of the remaining two connected regions.

[0068]

[33] Another semiconductor laser apparatus of the present invention includes: a first semiconductor laser light source for emitting a light beam with wavelength λ1; a second semiconductor laser light source for emitting a light beam with wavelength λ2; and a photodetector formed of a photo detecting portion for receiving the light and for outputting an electric signal proportional to the amount of the light. The photodetector includes a photo detecting portion PD1 for receiving a light beam with wavelength λ1, a photo detecting portion PD2 for receiving a light beam with wavelength λ2, and a photo detecting portion PD0 for receiving both lights with wavelength λ1 and wavelength λ2. When a distance between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source is d1, a distance between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source is d2, and a distance between the light emitting spots of the first and second semiconductor laser light sources is d12, a distance between the center of the photo detecting portion PD1 and the light emitting spot of the first semiconductor laser light source is d1, and a distance between the center of the photo detecting portion PD2 and the light emitting spot of the second semiconductor laser light source is d2. Further, the following relationships are satisfied: $\lambda1/\lambda2 \fallingdotseq d1/d2$, $d2 = d1 + d12$, $d1 \fallingdotseq \lambda1 \cdot d12/(\lambda1 - \lambda2)$, and $d2 \fallingdotseq \lambda2 \cdot d12/(\lambda1 - \lambda2)$.

[0069]

[34] Another semiconductor laser apparatus of the present invention

includes: a first semiconductor laser light source for emitting a light beam with wavelength $\lambda 1$; a second semiconductor laser light source for emitting a light beam with wavelength $\lambda 2$; and a photodetector formed of a photo detecting portion for receiving the light beams and for outputting an electric signal proportional to the amount of the light. The photodetector includes a photo detecting portion PD1 for receiving light with wavelength $\lambda 1$, a photo detecting portion PD2 for receiving light with wavelength $\lambda 2$, and the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively. When information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the divided regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the divided regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0070]

[35] In the semiconductor laser apparatus of this configuration, preferably, the photo detection portion further includes a photo detecting portion PD0 for receiving both lights with wavelength $\lambda 1$ and wavelength $\lambda 2$, and a distance d1 between the center of the photo detecting portion PD0 and the light emitting spot of the first semiconductor laser light source and a distance d2 between the center of the photo detecting portion PD0 and the light emitting spot of the second semiconductor laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$,

[0071]

[36] In the semiconductor laser apparatus of the above-mentioned configuration [35], preferably, a distance d12 between the light emitting spots of the first and second semiconductor laser light sources satisfy the following relationships: $d2 = d1 + d12$, $d1 \fallingdotseq \lambda 1 \cdot d12/(\lambda 2 - \lambda 1)$, and $d2 \fallingdotseq \lambda 2 \cdot d12/(\lambda 2 - \lambda 1)$.

[0072]

In this configuration, the photo detecting portion PD0 may be divided into a plurality of regions, and output from the regions may be calculated to detect a tracking error signal. Furthermore, the output from the photo detecting portion PD0 may be calculated to detect an information signal.

[0073]

[37] In the semiconductor laser apparatus of the above-mentioned configuration [35], preferably, when d12 denotes a distance between the light emitting spot of the first semiconductor laser light source and the light emitting spot of the second semiconductor laser light source, a gap between the center of the photo detecting portion PD1 and the center of the photo detecting portion PD2 is set to be about twice d12.

[0074]

More preferably, the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of photo detecting portions respectively, and when information reproduction is carried out by the use of the light with wavelength $\lambda 1$, signals obtained from the divided regions of the photo detecting portion PD1 are calculated to detect a focus error signal, and when the information reproduction is carried out by the use of the light with wavelength $\lambda 2$, signals obtained from the divided regions of the photo detecting portion PD2 are calculated to detect a focus error signal.

[0075]

[38] In the semiconductor laser apparatus of the above-mentioned configuration [35], preferably, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into five strip-shaped regions. In the configuration, two of the five strip-shaped regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector.

[0076]

[39] In the semiconductor laser apparatus of the above-mentioned configuration [35], preferably, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into four strip-shaped regions. In the configuration, two of the four strip-shaped regions may be connected in the photodetector, and further the remaining two regions also may be connected in the photodetector.

[0077]

[40] In the semiconductor laser apparatus of the above-mentioned configuration [35], preferably, at least one of the photo detecting portion PD1 and the photo detecting portion PD2 is divided into six strip-shaped regions. In the configuration, two of the six strip-shaped regions may be connected in the photodetector, and further remaining two regions also may be connected in the photodetector. Furthermore, in the configuration, a focus error signal may be detected from outputs of the two connected regions,

and a tracking error signal may be detected from outputs of the remaining two connected regions.

[0078]

[41] In the semiconductor laser apparatus of any one of the above-mentioned configurations, preferably, the first semiconductor laser light source and the second semiconductor laser light source are formed monolithically on one semiconductor chip.

[0079]

[42] In the semiconductor laser apparatus of any one of the above-mentioned configurations, preferably, the photo detecting portion includes a photo detecting portion PD1 for receiving the light with wavelength λ1 and a photo detecting portion PD2 for receiving the light with wavelength λ2, the photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and the shape of the photo detecting portion PD1 is different from the shape of the photo detecting portion PD2.

[0080]

[43] In the semiconductor laser apparatus of any one of the above-mentioned configurations, preferably, the photo detecting portion includes a photo detecting portion PD1 for receiving the light with wavelength λ1 and a photo detecting portion PD2 for receiving the light with wavelength λ2. The photo detecting portion PD1 and the photo detecting portion PD2 are divided into a plurality of regions respectively, and a symmetrical central line parallel to the dividing line of the photo detecting portion PD2 and a symmetrical central line parallel to the dividing line of the photo detecting portion PD1 are deviated from each other in the direction perpendicular to each symmetrical central line.

[0081]

[Mode for carrying out the invention]

Hereinafter, the present invention will be described by way of embodiments with reference to the accompanying drawings.

[0082]

(First Embodiment)

Figure 1 is a view showing a configuration of an optical pick-up according to a first embodiment of the present invention. In Figure 1, a semiconductor laser light source includes a red laser 1a and an infrared laser 1b. Reference numerals 81, 82 and 83 denote optical detecting

portions (PD0, PD1 and PD2) carrying out a photoelectric conversion, that is, receiving light beams and converting the received light beams into electric signals such as electric current. Reference numeral 3 denotes a grating; and 4 denotes a hologram or a diffractive element (i.e., an optical element in which a phase or a transmissivity has a periodical structure. The period or direction, that is, a grating vector, may vary depending on the parts. Hereinafter, a hologram is referred to as a representative example.) Reference numeral 5 denotes a collimating lens; 6 denotes an objective lens; and 7 denotes an optical disk.

[0083]

As mentioned below, the optical disk 7 includes CD, CD-R or the like having a base material thickness t1 of about 1.2 mm and DVD (DVD-ROM, DVD-RAM, or the like) having a base material thickness t2 of about 0.6 mm. Herein, the base material thickness denotes a thickness between a surface where light beams output from the objective lens enters and an information recording surface. Hereinafter, an optical disk having a base material thickness of about 1.2 mm and having the same recording density as that of CD-ROM will be referred to as a CD optical disk, and an optical disk having a base material thickness of about 0.6 mm and having the same recording density as that of DVD-ROM will be referred to as a DVD optical disk.

[0084]

As one example, separate semiconductor laser chips, that is, a red laser 1a and an infrared laser 1b, can be arranged in a form of hybrid. In this case, since each semiconductor laser chip can be made to be a minimum size and can be produced by respective optimum methods, it is possible to realize low noise, low consumption of electric current, and high durability property. As another example, a red laser 1a and an infrared laser 1b may be formed into one semiconductor laser chip monolithically. In this case, it is possible to reduce the manhours for assembling steps or to determine a distance between two light emitting points exactly. These configurations can be applied for the following optical pick-ups and all the embodiments.

[0085]

The photo detecting portions 81, 82, and 83 respectively correspond to PD0, PD1, and PD2, which are mentioned in [Means for solving problem] of this specification. The photo detecting portions 81, 82, and 83 are separated in Figure 1. However, by forming them on a single silicon substrate, the relative positional relationship of them can be determined

precisely.

[0086]

An operation of recording or reproducing information on the optical disk will be described with reference to Figures 2 and 3. Figure 2 is a view to explain an operation of recording or reproducing information on a DVD (DVD-ROM, DVD-RAM, etc) optical disk 71 having a base material thickness t2 of about 0.6 mm by using the red laser 1a.

[0087]

The red light beam 2 emitted from a red laser 1a passes through a grating 3 and a hologram 4, and is collimated by a collimating lens 5 into a nearly parallel light beam, and converged onto an optical disk 71 by an objective lens 6. Furthermore, the red light beam 2 is diffracted and reflected by pits or track grooves formed on the information recording surface of the optical disk 71. Thereafter, the light beam returns on substantially the same optical path by way of the objective lens 6 and the collimating lens 5, and again enters the hologram 4 to generate a +first-order diffracted light 10 and a −first-order diffracted light 11. The +first-order diffracted light 10 and the −first-order diffracted light 11 enter the photo detecting portion 81 and the photo detecting portion 82 respectively, and are photoelectrically converted. Herein, when the distance between the center of the photo detecting portion 81 and the light emitting spot of the red laser 1a is set to be d1, it is necessary that the distance between the center of the photo detecting portion 82 receiving −first-order diffracted light 11 that is conjugated with respect to the +first-order diffracted light 10 also should be set to be about d1.

[0088]

Figure 3 is a view to explain an operation of recording or reproducing information on a CD (CD-ROM, CD-R, etc.) optical disk 72 having a base material thickness t1 of about 1.2 mm by using the red laser 1b.

[0089]

The infrared light beams 25 emitted from the infrared laser 1b are diffracted in transmitting the grating 3 to generate ±first-order sub-spots, pass through the hologram 4 together with a zero-order diffracted light (main spot), are collimated by a collimating lens 5 into nearly parallel light beams, and converged onto an optical disk 71 by an objective lens 6. Furthermore, the infrared light beams 25 are diffracted and reflected by pits

or track grooves formed on the information recording surface of the optical disk 71. Thereafter, the light beam returns on substantially the same optical path by way of the objective lens 6 and the collimating lens 5, and enters the hologram 4 to generate a +first-order diffracted light 12 and a −first-order diffracted light 13. The +first-order diffracted light 12 and −first-order diffracted light 13 enter the photo detecting portion 81 and the photo detecting portion 83 respectively, and are converted photoelectrically. Herein, when the distance between the center of the photo detecting portion 81 and the light emitting spot of the red laser 1b is set to be d2, it is necessary that the distance between the center of the photo detecting portion 83 receiving −first-order diffracted light 13 that is conjugated with respect to the +first-order diffracted light 12 also should be set to be about d2.

[0090]

Figure 4 is a view showing a grating cross-sectional shape of the diffraction gating 3. The grating cross-sectional shape of the grating 3 is substantially a rectangular shape, and the width of the concave portions and the width of the convex portions are substantially the same width. The level difference h between the concave portion and the convex portion of the cross sectional shape of the grating is represented by the following relationship (1) when $\lambda 1$ denotes a wavelength of the red light beam 2, and n1 denotes a refractive index of a material of the grating with respect to the wavelength $\lambda 1$:

$$h = \lambda 1/(n1 - 1) \qquad (1)$$

Herein, the difference in an optical path between the concave portion and the convex portion is set to correspond to one wavelength with respect to the red light beam. By doing so, a phase difference due to the difference of the optical path becomes 2π. Thus, in design, the red light is not diffracted by the grating 3 and uses light efficiently without the loss of the light amount. Furthermore, since the wavelength of the infrared light is longer than that of the red light, the difference in the optical path generated due to the level difference h is smaller than one wavelength and also the phase difference is smaller than 2π and diffraction occurs, thus enabling sub-spots to be generated as mentioned above.

[0091]

Moreover, reproducing information on a CD optical disk by using an infrared light beam requires the NA of 0.45 or more. It is necessary to form

grating stripes in the sufficiently broad range of the grating 3 so that the diffracted light beams are generated from the entire range in which the NA of the sub-beam becomes 0.45 at the objective lens 6.

[0092]

Furthermore, it is desirable in design that the red light beam 2 is not diffracted as mentioned above. It is thought that the diffraction somewhat occurs due to the manufacturing error. When a part of the red light beam 2 transmits a portion of the grating 3 not including grating stripes and enters the objective lens 5, the inconsistency of strength and phase (difference depending on places) occurs between the part of the red light beam 2 passing through the portion without including grating stripes of the grating 3 and entering the objective lens 5 and the red light beam 2 passing through the grating stripes, which may lead to deterioration in the performance of converging light beams onto the recording surface of the optical disk 71. Therefore, it is desirable that the grating stripes are formed on the entire range in which the light beam entering the objective lens without being diffracted by the grating 3 satisfies the NA (0.6) that is necessary to the information reproduction on a DVD optical disk.

[0093]

However, when the diffracted light 12 or diffracted light 13, which is reflected by and returned from a CD optical disk 72, enters the hologram 4 and diffracted, enters the diffracted stripes, the light is diffracted further, thus causing the loss of the amount of light. In order to avoid the loss of the light amount, it is necessary to limit the range of the grating stripes on the grating 3.

[0094]

For example, by forming grating stripes in the portion shown as the grating 3 in Figure 1, the converging spot performance can be secured when information reproduction is carried out on a DVD optical disk. Furthermore, the loss of the light amount can be prevented when reproducing information on the CD optical disk. The grating 3 includes grating stripes, and has a transparent substrate (not shown in figure) in the broader range, and the diffracted light 12 or diffracted light 13 passes through the transparent portion (on which the grating stripes are not formed).

[0095]

Furthermore, a DVD optical disk is a higher density optical disk

compared with a CD optical disk. The DVD disk is required to reproduce (or record) information with a converging spot having less aberration than that of the CD optical disk. Therefore, it is desirable that the light emitting spot of the red laser 1a is arranged on the optical axis (in this embodiment, an optical axis of the collimating lens 5) of the light converging system within the range of the assemble tolerance. Therefore, off-axis aberration does not occur when information reproduction is carried out on the DVD optical disk. Thus, it is possible to reproduce (or to record) information on the DVD optical disk stably and with higher density.

[0096]

Furthermore, the relationship between the distance d1 from the center of the photo detecting portion 81 to the light emitting spot of the red laser 1a and the distance d2 from the center of the photo detecting portion 81 to the light emitting spot of the infrared laser 1b and the wavelength is described. Since the diffracting distance is substantially proportional to the wavelength, arranging is carried out so that the relationship (2) is satisfied:

$$d1 : d2 = \lambda 1 : \lambda 2 \qquad (2)$$

in the above-mentioned relationship, λ1 denotes a wavelength of the red laser and λ2 denotes a wavelength of the infrared laser. Thus, the photo detecting portion 81 can be used in both wavelengths and the number of the photo detecting portions can be reduced. Therefore, it is possible to reduce the area of the photodetector and the number of the circuit elements converting an output into current/voltage signals. Consequently, it is possible to realize the cost reduction and the miniaturization of the apparatus.

[0097]

As is apparent from Figures 2 and 3, when the distance between the light emitting spot of the red laser 1a and the light emitting spot of the infrared laser 1b is d12, the following relationship is satisfied:

$$d2 = d1 + d12 \qquad (3)$$

from the relationships (2) and (3), the following relationships (4) and (5) are satisfied:

$$d1 = \lambda 1 \cdot d12/(\lambda 2 - \lambda 1) \qquad (4)$$

$$d2 = \lambda 2 \cdot d12/(\lambda 2 - \lambda 1) \qquad (5)$$

By using this arrangement, since the photo detecting portion 81 commonly can be used for both wavelengths, and the number of the photo detecting

portions can be reduced, it is possible to reduce the area of the photodetector and the number of the circuit elements converting output signals into current/voltage signals, thus enabling the cost reduction and the miniaturization of the apparatus to be realized.

[0098]

(Second Embodiment)

Figures 5 and 6 show a configuration of a thin optical pick-up by using a rising mirror of the second embodiment. Figure 5 shows a case where information is reproduced on a DVD optical disk by using an emitted red light beam 2. Figure 6 shows a case where information is reproduced on a DVD optical disk by using an emitted infrared light beam 25.

[0099]

The light collimated by the collimating lens 5 into nearly parallel beam of light is reflected by the rising mirror 17 and changes the direction of moving, thereby reducing the size (thickness) of the optical pick-up in the direction perpendicular to the plane of the optical disk 7.

[0100]

As shown in Figure 5, a wavelength selection aperture 18 just serves as a transparent substrate with respect to the red light beam 2 and does not act on it. As shown in Figure 6, the wavelength selection aperture 18 shields light beams distant from the optical axis with respect to the infrared light beam 25. This wavelength selection aperture 18 can be formed by forming dielectric multi-layered films having different wavelength properties in the vicinity of the optical axis and on the outer peripheral portion distant from the optical axis, or by forming a phase grating having different phase modulation amounts. Since the DVD optical disk has higher recording density, information reproduction requires a larger NA as compared with a CD optical disk. Therefore, by using the means for changing the NA in accordance with the wavelength, NA is set to be a necessary minimum when reproducing information on a CD optical disk while reducing the aberration due to the thickness of the base material or the inclination of disk.

[0101]

In Figures 5 and 6, reference numeral 15 denotes a package. The package 15 includes, as shown in Figure 1, at least a red laser 1a and an infrared laser 1b and photodetector in which photo detecting portions 81-83 are formed. One component in which a light source and photodetector are

integrated into one piece will be referred to as a unit in the following. The hologram 4 may be formed near the collimating lens 5. However, by integrating also the hologram 4 into the unit 16, it is possible to fix the components necessary to produce servo signals closely to each other. Therefore, it is possible to detect servo signals stably, which are not susceptible to a distortion due to a change in temperature.

[0102]

Moreover, the hologram 4 may be fixed to the objective lens 6 and driven together. When reproducing information on DVD-RAM, diffracted light output from the hologram 4 is received at the dividing region of the photodetector, the differential calculation of the output signal is carried out, and a tracking error (TE) signal is obtained by the push-pull (PP) method. At this time, when a far-field pattern (FFP) moves with respect to the hologram 4 due to the movement of the objective lens 6, a TE signal offset occurs. However, if the objective lens 6 and the hologram 4 are driven together, even if the objective lens 6 moves, the relative positional relationship between the FFP that transmits the objective lens 6 and hologram 4 is constant. Therefore, it is possible to solve such an element of uncertainty as an occurrence of TE offset.

[0103]

(Third Embodiment)

Figure 7 shows a photodetector 8 according to a third embodiment. The photodetector 8 has a configuration in which the red laser 1a and the infrared laser 1b, and the photo detecting portions 81 to 83 are integrated. The photodetector 8 includes photo detecting portions 81 to 83 formed on a silicone substrate, etc. By integrating all of the photo detecting portions on one substrate like this, it is possible to reduce the manhours for electrical connection and to determine the relative positions between the photodetectors with high precision. Reference numeral 1 denotes a laser light source such as a semiconductor laser in which a red laser and an infrared laser are integrated monolithically. By forming lasers having two different wavelengths on one chip of the semiconductor laser light source 1 like this, the distance between the light emitting spot of the red laser and the light emitting spot of the infrared laser can be set precisely in a μm order or sub-μm order. Therefore, the detecting signal using lights of both wavelengths exhibits excellent properties.

[0104]

A small reflecting mirror 14 is provided in the direction in which the red light beam 2 or the infrared light beam 25 is emitted from the laser source 1. The mirror 14 allows the optical axis of the red light beam 2 or the infrared light beam 25 to be bent into the direction perpendicular to the surface made by the photo detecting portions 81 to 83. This mirror 14 can be formed by anisotropic etching of the silicon of the substrate, or adhering the small size prism mirror to the photodetector 8. By providing a photo detecting portion 89 also on the side opposite to the mirror 14 with respect to the laser light source 1, the amount of light emitted from the laser light source 1 in the direction of the photo detecting portion 89 can be detected, and the detected signals at the photo detecting portion 89 can be utilized for the signal for controlling the amount of light.

[0105]

Next, detailed configurations of the photo detecting portions 81 to 83 and the hologram 4 will be explained with reference to Figures 8, 9, and 10. The entire configuration of the optical pick-up is the same as in Figure 1 and the basic operation thereof is the same as in Figures 2 and 3.

[0106]

Figure 8 is a view of the photodetector 8 seen from the direction perpendicular to the surface thereof. The red light spot 4R denotes an effective diameter of the red light beam on the hologram 4 (that is, a projection of the effective diameter of the objective lens 5). P4A to P4D, M4A to M4D show a projection of the diffracted light output from the hologram 4 on the photodetector 8. The infrared light spot 4R corresponds to a part of the hologram 4 and the hologram 4 is formed in the range broader than the infrared light spot 4R. 1aL denotes a light emitting spot of the red laser 1a, and the red light spot 4R on the hologram 4 expands with the light emitting spot 1aL as a center.

[0107]

The photo detecting portions 81, 82, and 83 are formed on the common substrate. Therefore, it is possible to determine the positional relationship to each other precisely and easily. Furthermore, by forming also a semiconductor laser on the same substrate, the relative positional relationship with respect to the photodetecting portion becomes stable, thus enabling servo control signals to be obtained stably. Moreover, the photo detecting portions 81, 82, and 83 may be formed individually on a Si substrate, etc. in a hybrid form, or some parts of them may be formed on the

common substrate.

[0108]

P4A, P4B, P4C, and P4D are +first order diffracted light diffracted by the hologram 4. M4A, M4B, M4C, and M4D are −first order diffracted light diffracted by the hologram 4. The hologram 4 is divided into at least four parts by an x-axis and a y-axis. The hologram is designed so that P4A and M4A are diffracted by the region 4A, P4B and M4B are diffracted by the region 4B, P4C and M4C are diffracted by the region 4C, and P4D and M4D are diffracted by the region 4D.

[0109]

A focus error signal (FE signal) can be obtained by receiving −first order diffracted light M4A, M4B, M4C, and M4D, which are diffracted by the hologram 4, at the photo detecting portion 82. For example, a wavefront is designed so that M4A and M4D are focused on the side opposite to the collimating lens 5 (see Figure 1) with respect to the surface of the photo detecting portions 82 (this will be referred to as a rear pin); and M4B and M4C are focused on the same side as the collimating lens 5 with respect to the surface of the photo detecting portion 82 (this will be referred to as a front pin).

[0110]

In other words, the wavefronts having different focusing positions are formed in the direction of the optical axis. Therefore, when a gap between the DVD optical disk 71 and the objective lens shifts in the direction of the optical axis, that is, in the front and the rear sides of the position where the converging spot is focused on the information recording surface, the magnitude of the diffracted light on the photo detecting portion 82 is changed, respectively. This change is a movement that becomes contrary to the difference in the focusing positions (for example, M4A and M4D become larger, and M4B and M4C become smaller).

[0111]

Therefore, FE signals can be obtained by calculating differences of F1 and F2 from the following formula (6):

$$FE = F1 - F2 \qquad (6)$$

wherein F1 and F2 respectively denote a sum of outputs of each strip region in which the sum is obtained by connecting the divided regions as shown in Figure 8.

[0112]

Furthermore, TE signals are obtained as follows. The y-direction of the photodetector 8 is adjusted to the projection direction of the direction in which a track of the DVD optical disk 71 extends (tangential direction), and the x-direction is adjusted in a radiation direction extending from the center of the disk to the outer peripheral portion (radial direction). As shown in Figure 9, a recordable optical disk such as DVD-RAM and the like has guide grooves, and the disk is affected strongly by the diffraction of the guide grooves. Moreover, the upper half of Figure 9 is drawn by an elevational view, and the lower half of the Figure 9 is drawn by a plan view for ease of explanation. In Figure 9, reference numerals 25, 26, and 27 denote a zero-order, +first-order, and −first order diffracted light due to the guide groove on the optical disk recording surface 24, respectively. Furthermore, reference numeral 84 denotes a two-divided photodetector for explanation. The photodetector 84 shows a state seen from the direction of the optical axis that is a direction perpendicular to the optical disk surface 24, the objective lens 6.

[0113]

When the guide groove of the information recording surface 24 of the optical disk is irradiated with a converging spot, the reflected light is diffracted in the direction perpendicular to the direction in which the guide groove extends. An optical intensity distribution in portions A and B occurs in the far-field pattern (FFP) 28 due to the interference of the ±first order diffracted light and zero order diffracted light in the guide groove. Depending upon the positional relationship of the guide groove and the converging spot, A may be bright and B may be dark and A may be dark and B may be bright. By detecting such a change of the optical intensity by the use of a 2-divided photodetector, TE signals can be obtained by the PP method.

[0114]

In the embodiment shown by Figure 8, since the hologram 4 (Figure 8 only shows a red light 4R on the hologram) is positioned in the two-divided photodetector 84 in Figure 9, when the divided regions of the hologram 4 and the divided regions of the photo detecting portion where the diffracted lights reach from each divided region are taken into account, the tracking error (TE) signals can be obtained by the push-pull method by calculating from the following relationship (7).

$$TE = (TA + TB) - (TC + TD) \qquad (7)$$

wherein signal strength is expressed by the name of the region (the same as true in the following).

[0115]

Furthermore, when reproducing information on DVD-ROM, it is necessary to use TE signals by the phase difference method. In such a case, however, by comparing the phase of the signal (TA + TC) with the signal (TB + TD), TE signals can be obtained by the phase difference method. Also, it is possible to detect TE signals by the phase difference method by comparing the phase of TA and TB with the phase of TC and TD.

[0116]

As mentioned above, among the diffracted lights for detecting the FE signal received at the photo detecting portion 82, for example, M4A and M4D are focused on the opposite side of the collimating lens 5 (Figure 1) with respect to the surface of the photo detecting portion 82, and M4B and M4C are focused on the same side as the collimating lens 5 (Figure 1) with respect to the surface of the photo detecting portion 82. In other words, the diffracted light diffracted from the region 4A of the hologram 4 and the diffracted light diffracted from the region 4D of the hologram 4 have the same property.

[0117]

When equalizing the property of the hologram 4 at the diffracted light diffracted from the region symmetrical to the y-axis corresponding to the tangential direction of the optical disk 7, when FE signals are detected, in the change in the amount of lights A and B described with reference to Figure 9, both diffracted light diffracted from the regions symmetrical to the y-axis are offset by each other. Therefore, it is possible to prevent the contamination of TE signal into FE signals, i.e., the occurrence of the groove traverse signal because of the diffracted light diffracted from the regions.

[0118]

Next, the information (RF) signals can be obtained from the following relationship (8):

$$RF = TA + TB + TC + TD \qquad (8)$$

Furthermore, the RF signals can be obtained from the following relationship (9) by using all the ±first-order diffracted lights, and it is possible to improve the ratio of signal/noise (S/N) with respect to the electrical noise.

$$RF = TA + TB + TC + TD + F1 + F2 \qquad (9)$$

[0119]

Moreover, as shown in Figure 8, by forming the region 82 of the five strip shaped divided regions, it is possible to separate the diffracted light M4D from the diffracted light M4A appropriately. Furthermore, it is possible to separate the diffracted light M4D from the diffracted light M4A appropriately. Accordingly, the conjugated lights thereof, that is, the diffracted light P4D can be separated from P4A appropriately. Similarly, the diffracted light P4B can be separated from P4C appropriately. Therefore, in the photo detecting portion 81, signals of the four diffracted lights can be detected separately and thus TE signals can be obtained by the phase difference method more excellently.

[0120]

Figure 10 shows an operation of recording or reproducing information on a CD optical disk by emitting an infrared light in the same configuration as in Figure 8. As shown in Figure 3, the infrared light beam 25 is partially diffracted by the grating 3 to generate sub-beams. These sub-beams as well as the main beams are converged onto the CD optical disk 72 and reflected thereby, and enters the photo detecting portion 8. Unlike the red light beam in Figure 8, the infrared light beam enters the photo detecting portion 81 and the photo detecting portion 83. The region of the photo detecting portion 81, in which the main beam enters, is the same as in the Figure 8. The operation is also the same. The region of the photo detecting portion 83, in which the main beams enter, corresponds to the region of the photo detecting portion 82 and the operation is also the same. The sub-beams enter the divided regions TF and TG of the photo detecting portion 81 and the divided regions TH and TI of the photo detecting portion 83. The infrared light spot 4IR of Figure 10 shows the main beam of the red light spot 4R in Figure 8. 1bL denotes a light emitting spot of the infrared laser 1b and the spot of the infrared light spot 4IR on the hologram 4 expands around the light emitting spot 1bL as a center.

[0121]

First, the production of the FE signal is described. Basically, the same explanation is applied as in the case of Figure 8. When the gap between the CD optical disk 72 and the objection lens in the direction of the optical axis is shifted, that is, when defocusing occurs, the magnitude of the diffracted light on the photo detecting portion 83 changes. The change moves in the direction opposite to the difference of the focus position.

Therefore, FE signals can be obtained by calculating differences of F3 and F4 from the following formula (10):

$$FE = F3 - F4 \qquad (10)$$

wherein F3 and F4 respectively denote a sum of outputs of each strip region in which the sum is obtained by connecting the divided regions of the photo detecting portion 83 as shown in Figure 10. Moreover, since the hologram 4 is divided into four regions by the x-axis and y-axis, the magnitudes of the four diffracted lights for detecting signals of F3 and F4 are not the same as each other, which does not affect the detection of FE signal because in the hologram 4, the regions A and D and the regions B and C are a combination of a large region and a small region, respectively.

[0122]

Furthermore, by connecting, for example, F1 and F3, F2 and F4 in the photodetector 8, it is possible to reduce the number of I-V amplifiers for converting a current signal obtained from the photo detecting portion into a voltage signal, or the number of the electric terminals for taking out signals from the unit to the outside, thus enabling the unit to be minimized.

[0123]

The thickness of the base material of DVD is different from that of CD. Therefore, by detecting FE signals on the same shaped photo detecting portion, the offset may occur in the FE signals due to the spherical aberration. Thus, as shown in Figure 10, the symmetric line (central line) along the x-axis of the photo detecting portion 83 is arranged by shifting it with respect to the symmetric line along the x-axis of the photo detecting portion 82. According to Figure 10, when two dividing lines in the x-axis direction forming the central strip regions in the photo detecting portion 83 and the symmetric line of the photo detecting portion 82 are expressed by a and b, a is not equal to b. Furthermore, since the magnitude of the diffracted light becomes different due to the effect of the wavelength spherical aberration, by changing the widths of the strips between the photo detecting portion 82 and the photo detecting portion 83, it is possible to obtain an FE signal having a high sensitivity and a broad dynamic range.

[0124]

When reproducing information on CD, TE signals can be detected by the phase difference method similarly to the time of information reproduction on DVD. However, in CD-R, the 3-beam method is secured in the standardization. Therefore, for detecting TE signals, in the

configuration, sub-beams entering the divided regions TF, TG, TH, and TI of the photodetector 8 are allowed to be used. TE signals by the 3-beam method can be detected by calculating the following relationship (11).

$$TE = (TF + TH) - (TG + TI) \qquad (11)$$

[0125]

In the photodetector 8, by interconnecting TF and TH by the use of an aluminum wiring or the like, it is possible to reduce the number of the output terminals to the outside, and to miniaturize the unit. The same is true in TG and TI.

[0126]

Furthermore, TE signals can be detected by the 3-beam method by the use of the following relationship (12) or (13):

$$TE = TF - TG \qquad (12)$$

$$TE = TH - TI \qquad (13)$$

In this case, it is possible to reduce the number of the output terminals to the outside and to miniaturize the unit.

[0127]

Next, information (RF) signals can be obtained from the following relationship (14):

$$RF = TA + TB + TC + TD \qquad (14)$$

The information (RF) signals can be obtained from the following relationship (15) by using all the ±first-order diffracted lights, thereby it is possible to improve the ratio of signal/noise (S/N) with respect to the electrical noise.

$$RF = TA + TB + TC + TD + F3 + F4 \qquad (15)$$

[0128]

As is apparent from the above-mentioned relationships (4) and (5) and Figure 8 or Figure 10, a gap between the center of the photo detecting portion 82 and the center of the photo detecting portion 83 is set to be twice d12. Thereby, each center of the photo detecting portion and the center of the diffracted light can be accorded and the light can be received without leakage if there is an error in the change of the wavelength.

[0129]

Furthermore, in the above-mentioned figures, etc., F1, F2, F3, and F4 are described in a way in which they are individual, respectively. However, for example, by interconnecting F1 and F3, and F2 and F4, it is possible to reduce the number of the output terminals to the outside and to

miniaturize the unit.

[0130]

(Fourth Embodiment)

The fourth embodiment will be explained with reference to Figures 11 and 12. Figure 11 is a view of the photodetector 801 seen from the direction perpendicular to the surface thereof. The red light spot 401R shows an effective diameter (that is, the projection of the effective diameter of the objective lens 5) of the light beam on the hologram. P401A to P401D, M401A to P401D show the projection on the photodetector 801 of the diffracted light generated from the hologram. The photodetector 801 corresponds to the modification of the photodetector 8 in the third embodiment. The photo detecting portions 811, 821 and 831 correspond to the modification of the photo detecting portions 81, 82 and 83 in the third embodiment respectively. Similarly, the divided regions 401A, 401B, 401C, and 401D correspond to the modification of the photo detecting portions 4A, 4B, 4C, and 4D in the third embodiment respectively.

[0131]

When light is emitted from the red laser 1a, FE signals are obtained from the photo detecting portion 821. The photo detecting portion 821 includes four regions. Therefore, projections M401D and M401B are allowed to enter the same region. By reducing the number of regions as compared with the third embodiment, it is possible to reduce the area of the photo detecting portion and to reduce the effect of a stray light such as a scattered light. Therefore, FE signals can be obtained by the calculating the difference of F11 and F21 from the following formula (16):

$$FE = F11 - F21 \qquad (16)$$

wherein F11 and F21 respectively denote a sum of outputs of two regions, in which the sum is obtained by connecting the divided regions of the photo detecting portion 821 as shown in Figure 11. TE signals and RF signals also can be obtained as in the third embodiment.

[0132]

Figure 12 shows the light emitting time of the infrared laser 1b, that is, the time of the information reproduction on the CD optical disk. The infrared light spot 401IR is the same as the infrared light spot 41R in Figure 10.

[0133]

When light is emitted from the infrared laser 1b, FE signals are

obtained from the photo detecting portion 831. The central portion of the photo detecting portion 831 corresponding to the photo detecting portion 821 includes four regions. Thereby, it is possible to reduce the area of the photo detecting portion and to reduce the effect of a stray light such as a scattered light. Therefore, FE signals can be obtained by calculating the difference of F31 and F41 from the following formula (17):

$$FE = F31 - F41 \qquad (17)$$

wherein F31 and F41 respectively denote a sum of outputs of two regions, in which the sum is obtained by connecting the divided regions of the photo detecting portion 831 as shown in Figure 12. TE signals and RF signals also can be obtained as in the third embodiment.

[0134]

Since the configuration mentioned above is the same as in the third embodiment, the explanation is not repeated herein.

[0135]

(Fifth Embodiment)

The fifth embodiment will be explained with reference to Figures 13 and 14. Figure 13 is a view of the photodetector 802 seen from the direction perpendicular to the surface of thereof. The red light spot 402R shows an effective diameter (that is, the projection of the effective diameter of the objective lens 5) of the light beam on the hologram. Furthermore, the state of the diffracted light generated from the hologram on the photo detecting portions 812 and 822 is shown. The photodetector 802 corresponds to the modification of the photodetector 8 in the third embodiment. The photo detecting portions 812, 822 and 832 correspond to the modification of the photo detecting portions 81, 82 and 83 in the third embodiment respectively. Similarly, the divided regions 402A, 402B, 402C, and 402D correspond to the modification of the photo detecting portions 4A, 4B, 4C, and 4D in the third embodiment respectively.

[0136]

For example, the regions 402A and 402D in the hologram 4 are treated as one region so as to generate the diffracted light having two focuses on the front side and the rear side (front pin and back pin) in the optical axis direction with respect to the photodetector 802, and then superimposed on the divided regions for obtaining the signals F12 and F22 in the photo detecting portion 822 in Figure 13. In order to generate the diffracted light of the front pin and rear pin from the regions 402A and 402D,

for example, the region is further divided into a plurality of regions by the use of dividing lines extending in parallel to the y-axis and forming the grating for generating the diffracted light of the front pin and rear pin alternately. The diffracted light of the front pin and the rear pin are converged in the front side and the rear side of the photo detector 802 with respect to the direction along the y-axis. In the direction of the x-axis, both pins are converged onto the photodetector 802 and may be the focal line extending along the y-direction.

[0137]

The regions 402B and 402C of the hologram 4 emit the diffracted light entering the divided regions TA2 and TB2 of the photo detecting portion 822, respectively.

[0138]

All of the diffracted light mentioned above are diffracted to the photo detecting portion 822. However, the conjugated light thereof enters the divided region RF2 of the photo detecting portion 812.

[0139]

In the above-mentioned configuration, FE signals when the light is emitted from the red laser 1a can be obtained from the photo detecting portion 822.

The FE signal can be obtained by calculating the difference of F12 and F22 from the following relationship (18):

$$FE = F12 - F22 \qquad (18)$$

TE signals can be detected by the push-pull method from the following relationship (19):

$$TE = TA2 - TB2 \qquad (19)$$

Furthermore, TE signals can be detected by the phase difference method by comparing the phases of TA2 and TB2.

[0140]

The RF signal can be obtained from the signal in the RF2 region. In this embodiment, since it is possible to obtain the RF signal only from the region RF2, one I-V converting amplifier for RF signal, which can obtain the highest frequency property and S/N ratio, is necessary, thus minimizing the cost of the I-V converting amplifier.

[0141]

Figure 14 shows the light emission time of the infrared laser 1b, that is, the time of the information reproduction on the CD optical disk. The

infrared light spot 402IR is the same as the infrared light spot 41R in Figure 10.

[0142]

The diffracted light output from the divided region 402A and 402D of the hologram 4 becomes the optical spot of the front pin and the rear pin similar to the emission time of red laser, and then enter the divided regions F32 and F42 of the photo detecting portion 832. The diffracted light generated from the divided regions 402B and 402C (the boundary line herein denotes a y-axis) of the hologram 4 enters the region RF1. All of the diffracted light mentioned above are diffracted to the photo detecting portion 822. However, the conjugated light thereof enters the divided region RF2 of the photo detecting portion 812.

[0143]

Furthermore, as shown in Figure 3, the sub-beam, which is generated by the grating 3 in the outward path and is reflected by the CD optical disk 72 and diffracted by the hologram 4, enters the divided regions TF2 and TG2 of the photo detecting portion 812 and the divided regions TH2 and TI2 of the photo detecting portion 832.

[0144]

In the above-mentioned configuration, when the light is emitted from the infrared laser 1b, FE signals are obtained from the photo detecting portion 832.

FE signals can be obtained by calculating the difference of the signals of each region F32 and F42 by the use of the following relationship (20):

$$FE = F32 - F42 \qquad (20)$$

The TE signal of the 3-beam method can be obtained from the following relationship (21):

$$TE = (TF2 + TH2) - (TG2+TI2) \qquad (21)$$

Also, the RF signal can be obtained from the signal of the region RF.

[0145]

Since the configuration mentioned above is the same as in the third embodiment, the explanation is not repeated herein.

[0146]

In the above-mentioned embodiment, the DVD optical disk and the CD optical disk are explained as an example. However, the first optical disk having a transparent substrate thickness t1 and the second optical disk

having a thickness t2 (t2 is different from t1) may be reproduced or recorded as the optical disk 7. When t1 is set to be 0.6 mm and t2 is set to be 1.2 mm, the disk is broadly applied to DVD optical disks and CD optical disks presently available in the market. However, the thickness is not limited to this alone and other combination can be applicable. Furthermore, as the wavelength, $\lambda 1$ is a red laser having a wavelength of 610 nm to 680 nm and $\lambda 2$ is a red laser having a wavelength of 740 nm to 830 nm. One may be a violet light having a wavelength of about 400 nm. In other words, $\lambda 1$ and $\lambda 2$ may be of a combination other than the above.

[0147]

The main portion of the present invention explained in the above mentioned embodiment includes, for example, the unit 16 shown in Figure 15.

[0148]

In the optical pick-up of the present invention, since by detecting TE signals by the 3-beam method at the information reproduction time on CD, it is possible to obtain a stable TE signal in which the offset does not occur even if the position where the hologram element is provided differs from the regular position, the information reproduction can be carried out precisely and stably. This is also a characteristic of the unit of the present invention.

[0149]

(Sixth Embodiment)

Figure 15 shows an optical disk apparatus in the sixth embodiment using an optical pick up of the present invention. In Figure 15, the optical disk 7 is rotated by the optical disk driving mechanism 32. The optical pick up 20 is moved finely to the position of the track in which the predetermined information of the optical disk 7 exists, by an optical pick-up driving device 31.

[0150]

The optical pick-up 20 feeds a focus error signal and a tracking error signal to an electric circuit 33 in accordance with the positional relationship with respect to the optical disk 7. The electric circuit 33 responds to the signals and feeds signals for fluttering the objective lens to the optical pick-up 20. By this signal, the optical pick-up 20 carries out focus servo and tracking servo on the optical disk 7, reads out, or writes or erases information on the optical disk 7.

[0151]

According to the optical disk apparatus of this embodiment, as the optical pick-up, the optical pick-up of the present invention as explained in the above-mentioned embodiments, which is small in size and capable of obtaining an excellent S/N ratio at low cost, is used, and it is possible to reproduce information accurately and stably. Furthermore, an effect of having a small size and low cost can be provided.

[0152]

Furthermore, since the optical pick-up of the present invention has light weight and small size, the optical disk apparatus of this embodiment using this optical pick-up can achieve a shorter access time.

[0153]

(Seventh Embodiment)

A method of an optical disk type recognition process in the seventh embodiment will be described with reference to Figure 16. This embodiment relates to an optical disk type recognition method during the start-up right after the power is turned on or after the optical disk is replaced by another. The optical disk type recognition method includes the recognition of whether or not an optical disk exists in an optical disk apparatus, or whether the existing optical disk is CD or DVD, which has not yet been performed in the optical disk apparatus.

[0154]

In the above-mentioned embodiments, in the optical disk apparatus having an optical pick-up using an infrared light beam and a red light beam as a light source, when the power is turned on or the optical disk is newly inserted, first, the infrared light is emitted at low output that is equal to the level at the time of reproduction of signals (step S1). Thereby, even if the optical disk is CD-R, unnecessary writing of information or wrong erasing of necessary information can be prevented. Herein, the reason why a red light is not emitted first is as follows. The reflectance of the CD-R is controlled with respect to the infrared light, but is not controlled with respect to a red light. Consequently, the red light may have an extremely high absorption.

[0155]

Existence or nonexistence of an optical disk is determined by the existence or nonexistence of reflected light of the infrared light emitted in the above-mentioned manner (step S2), and if the optical disk does not exist, the light emission is stopped (step S3), thereby saving electric power.

When the optical disk exists, by the use of the reflected light from the optical disk, the kind of the optical disk is determined (step S4). In this embodiment, the determination of the kind of the optical disk is carried out by detecting a thickness t of a transparent substrate. Since the determination of the thickness can be carried out by the use of the well known method, the specific explanation therefor is omitted herein. In this embodiment, the kinds of the optical disk are discriminated by whether the thickness t is 0.6 mm or not. The method of determination of the kinds of the optical disk may be selected appropriately in accordance with the combination of the kinds of the optical disks.

[0156]

When the thickness t of the transparent substrate of the inserted optical disk is not 0.6 mm, the optical disk is judged to be CD, and in this case, emitting of the infrared light is continued (step S5), and the recording and reproducing of information starts (step S6). When the thickness t of the transparent substrate is 0.6 mm, the optical disk is judged to be DVD, and in this case, infrared light is turned off (step S7), red light is turned on (step S8), and the information recording or reproducing on DVD is carried out (step S9).

[0157]

It is desirable that the optical disk type recognition method of this embodiment is carried out in combination with the optical pick-up or the optical disk apparatus mentioned in the above-mentioned embodiments. However, the present invention is not limited to this configurations alone and is applicable to an optical disk apparatus having an optical pick-up using a plurality of the infrared light and the other wavelength as a light source. Thereby, even if the optical disk is CD-R, unnecessary writing of information or wrong erasing of necessary information can be prevented.

[0158]

(Eighth Embodiment)

Figure 17 shows a copying machine 50 according to the eighth embodiment. The copying machine 50 uses the optical pick-up or optical disk type recognition method mentioned above and includes an optical disk apparatus 30 capable of recording or reproducing information on the optical disk. The copying machine 50 is provided with various mechanisms included in a common copying apparatus such as a scanner capable of reading out a manuscript, a mechanism capable of feeding a copying paper,

and the like. However, these mechanisms are not shown herein. Reference numeral 51 denotes information input/output terminals for transmitting information to the other equipment via a cable or a network; 52 denotes a mechanism for feeding manuscript sheet (sheet feeder), and 53 denotes a finished paper receiving holder for holding the copied paper.

[0159]

The copying machine 50 has a function capable of copying on a copying paper as a usual copying machine. However, the copying machine can record information written in paper by sending information to the optical disk apparatus 30 by way of operation of the switch 54, or command sent via the information input/output terminal. At this time, the configuration capable of copying while recording is possible. With the mechanism for feeding manuscript sheet 52, a large amount of manuscript sheet can be copied and furthermore, the information printed on both surfaces of the paper can be stored as an electric information in the optical disk apparatus 30 rapidly. Thus, the storage space for information can be compressed in a short time.

[0160]

(Ninth Embodiment)

Figure 18 shows an image projecting apparatus according to the ninth embodiment. This image projecting apparatus includes an optical disk apparatus 30 using an optical pick-up or optical disk type recognition method mentioned in the above-mentioned embodiment. In Figure 18, reference numeral 62 denotes a front glass of a car; and 61 denotes an image projecting portion on which letters or pictures are depicted on the front glass 62 of a car.

[0161]

The information reproduced by the optical disk apparatus 30 are depicted onto the front glass 62 by an image projecting portion 61. The front glass 62 is basically made of transparent glass but it has reflectance of several %. Therefore, it is possible to depict the image onto the front glass. Furthermore, the front glass is not flat but has a curve, so that an image is distorted. Therefore, it is desirable that the information is processed by the use of the converting circuit 63 capable of converting information and by compensating the distortion, so an image without distortion is visible.

[0162]

[Effects of the invention]

According to the present invention, the following effects can be obtained.

(1) It is possible to reproduce information on both CD (CD-ROM, CD-R, etc.) and DVD (DVD-ROM, DVD-RAM, etc.) under significantly different optical conditions in terms of three factors, that is, a base material thickness, a wavelength of a light source, and NA.

(2) It is possible to obtain excellent signals at the information reproduction time on both DVD and CD with respect to the difference in the wavelength and difference in the position of the light emitting spot.

(3) It is possible to carry out the detection of TE signals by three kinds of methods, that is, the phase difference method, the PP method, and the 3-beam method, which are necessary to record or reproduce information on DVD-ROM, DVD-RAM, and CD-ROM, CD-R by the same apparatus.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1] Figure 1 is a schematic cross-sectional view showing an optical pick-up according to a first embodiment of the present invention.

[Fig. 2] Figure 2 is a schematic cross-sectional view showing an operation of the optical pick-up of Figure 1.

[Fig. 3] Figure 3 is a schematic cross-sectional view showing an operation of the optical pick-up of Figure 1.

[Fig. 4] Figure 4 is a cross-sectional view showing a grating used for the optical pick-up of Figure 1.

[Fig. 5] Figure 5 is a schematic cross-sectional view showing an operation of an optical pick-up according to a second embodiment.

[Fig. 6] Figure 6 is a schematic cross-sectional view showing an operation of an optical pick-up according to a second embodiment.

[Fig. 7] Figure 7 is a schematic perspective view showing a photodetector according to a third embodiment.

[Fig. 8] Figure 8 is a schematic plan view showing a configuration and an operation of a photodetector according to a third embodiment.

[Fig. 9] Figure 9 is a view to illustrate an operation of a photodetector according to a third embodiment.

[Fig. 10] Figure 10 is a schematic plan view showing an operation of a photodetector according to a third embodiment.

[Fig. 11] Figure 11 is a schematic plan view showing a configuration and an operation of a photodetector according to a fourth embodiment.

[Fig. 12] Figure 12 is a schematic plan view showing an operation of a

photodetector according to a fourth embodiment.

[Fig. 13] Figure 13 is a schematic plan view showing a configuration and an operation of a photodetector according to a fifth embodiment.

[Fig. 14] Figure 14 is a schematic plan view showing an operation of a photodetector according to a fifth embodiment.

[Fig. 15] Figure 15 is a schematic cross-sectional view showing an optical disk apparatus according to a sixth embodiment.

[Fig. 16] Figure 16 is a flow chart showing a method of an optical disk type recognition process according to a seventh embodiment.

[Fig. 17] Figure 17 is a schematic cross-sectional view showing a copying machine of an eighth embodiment.

[Fig. 18] Figure 18 is a schematic cross-sectional view showing an image projecting apparatus according to a ninth embodiment.

[Fig. 19] Figure 19 is a schematic cross-sectional view showing a conventional optical pick-up.

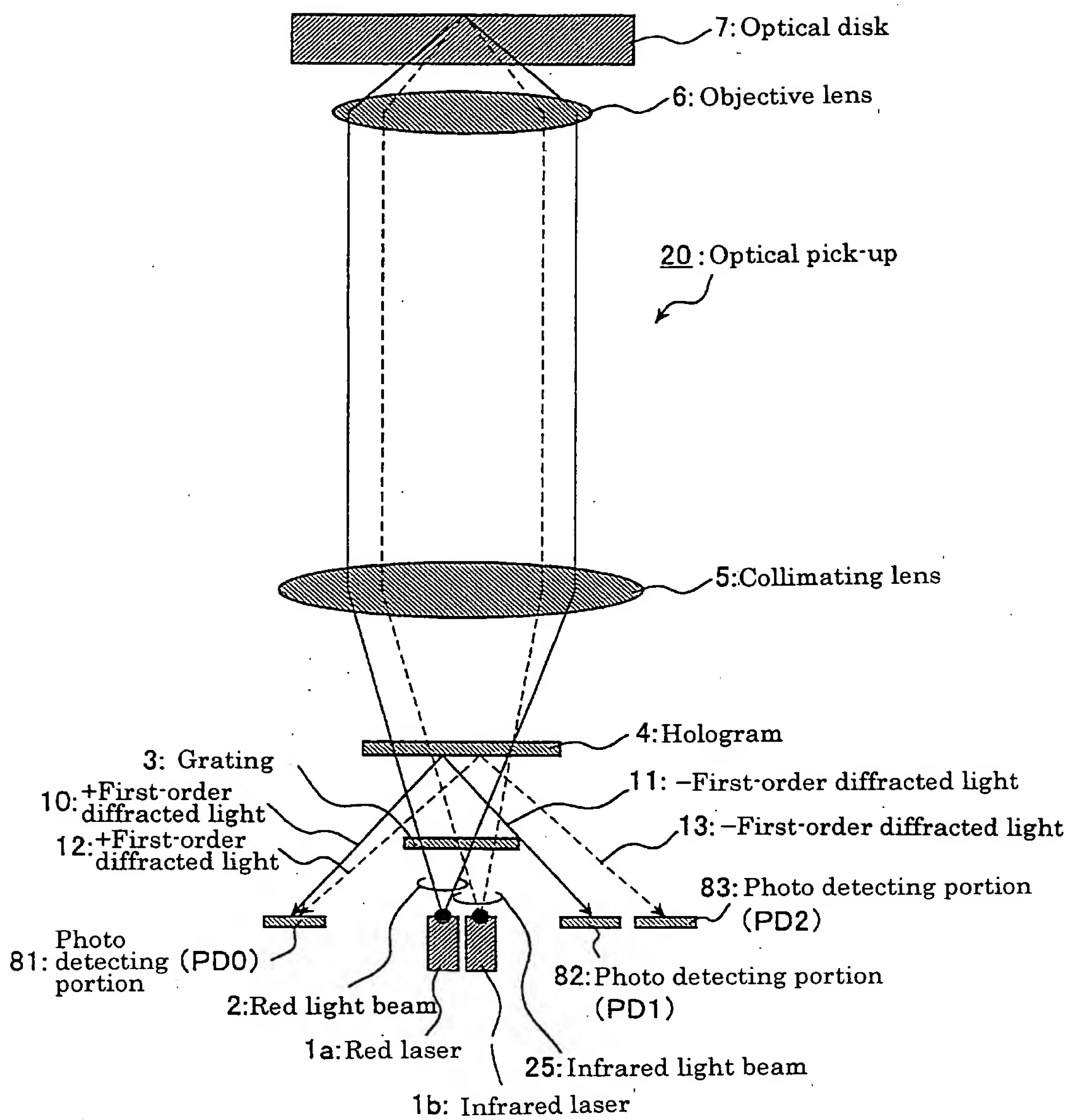
[Fig. 20] Figure 20 is a schematic perspective view showing a main part of a conventional optical pick-up.

[Explanation of letters or numerals]

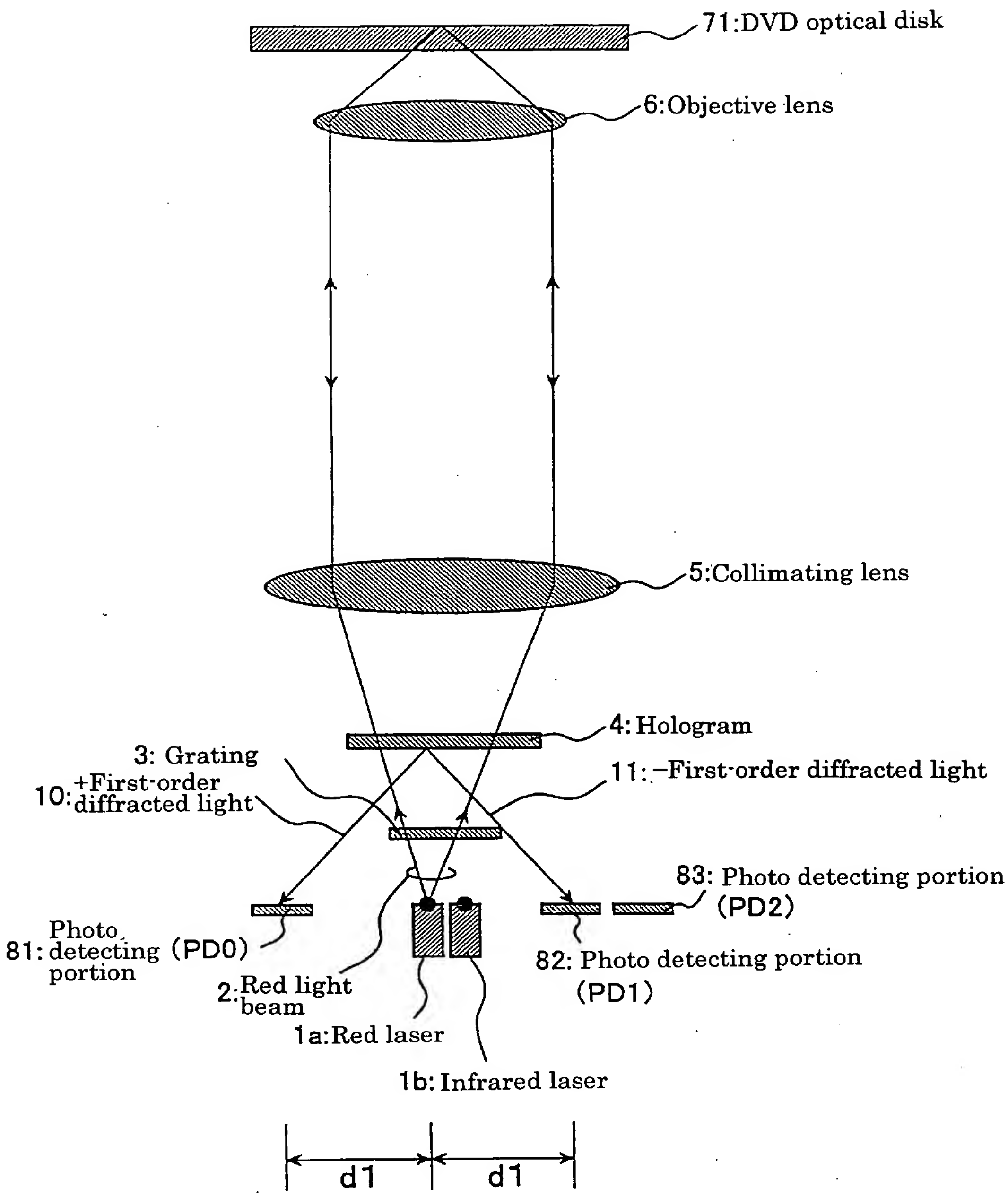
1 laser light source
1a red laser
1b infrared laser
2 red light beam
3 grating
4 hologram
6 objective lens
7 optical disk
8 photodetector
10, 12 +first order diffracted light
11, 13 −first order diffracted light
16 unit
20 optical pick-up
25 infrared light beam
30 optical disk apparatus
50 copying machine
62 front glass

[Document Name] Drawings

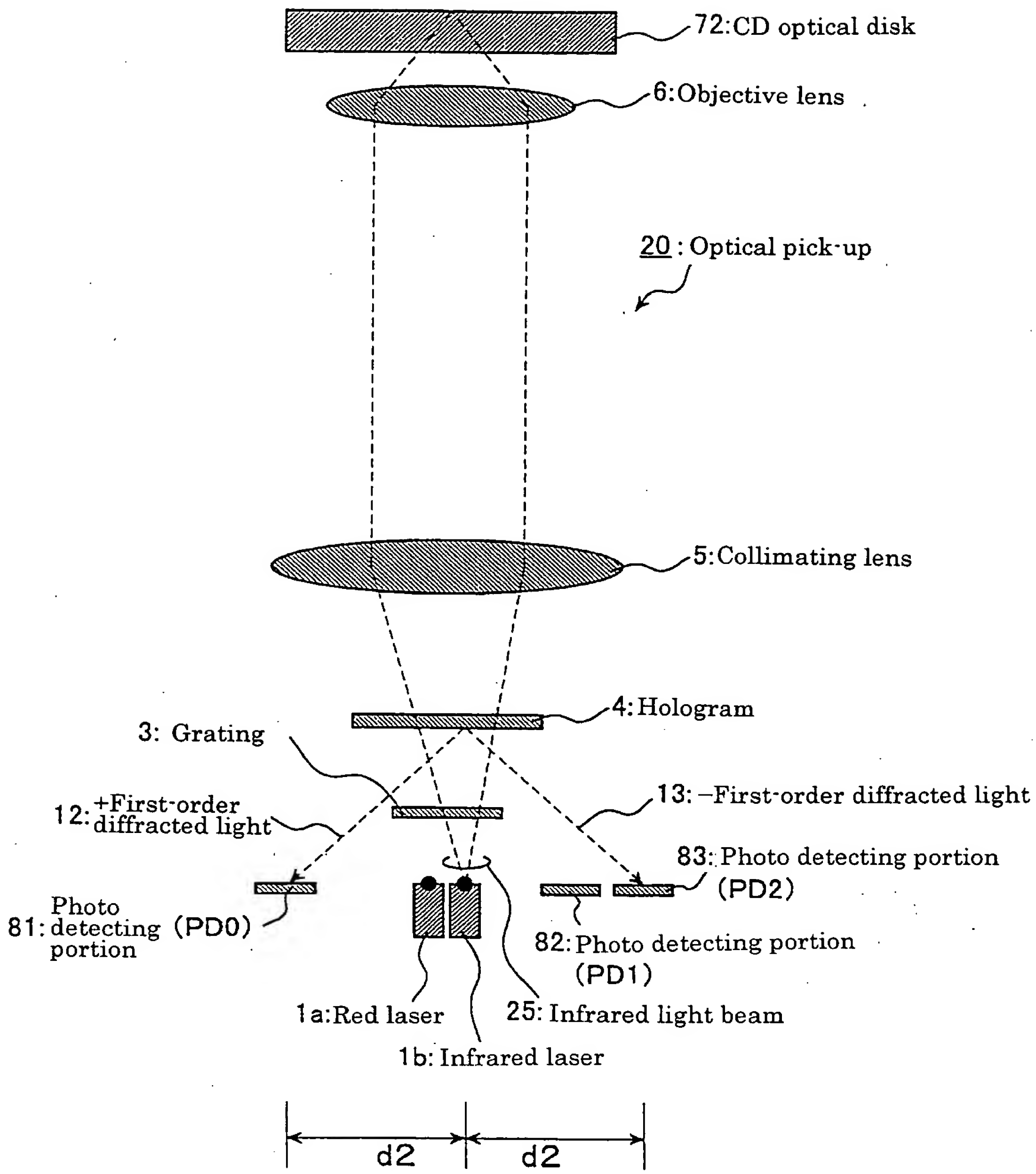
[Fig. 1]



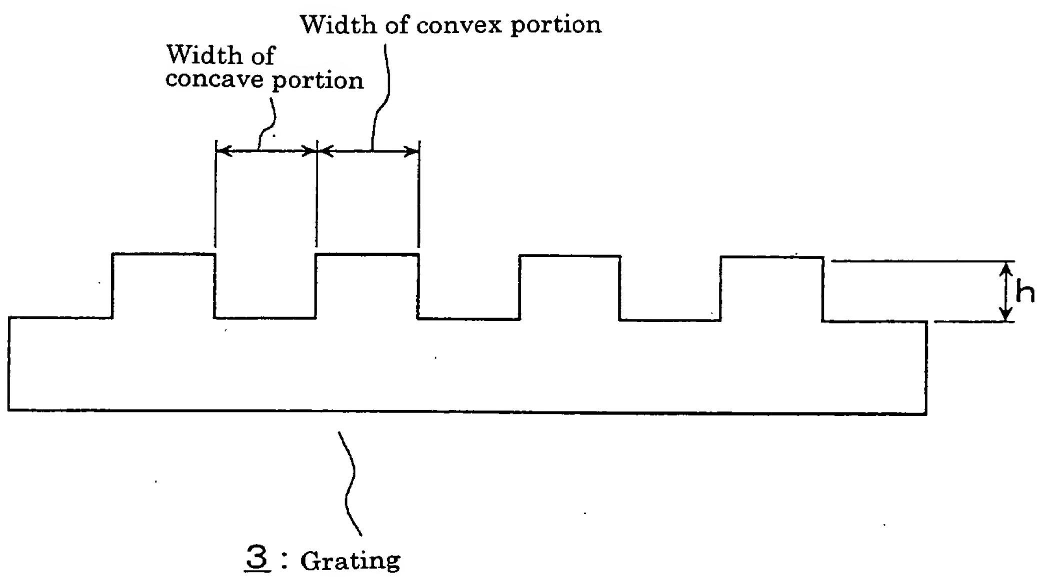
[Fig. 2]


71:DVD optical disk
6:Objective lens
5:Collimating lens
4: Hologram
3: Grating
10: +First-order diffracted light
11: −First-order diffracted light
83: Photo detecting portion (PD2)
81: Photo detecting (PD0) portion
82: Photo detecting portion (PD1)
2: Red light beam
1a:Red laser
1b: Infrared laser
d1
d1

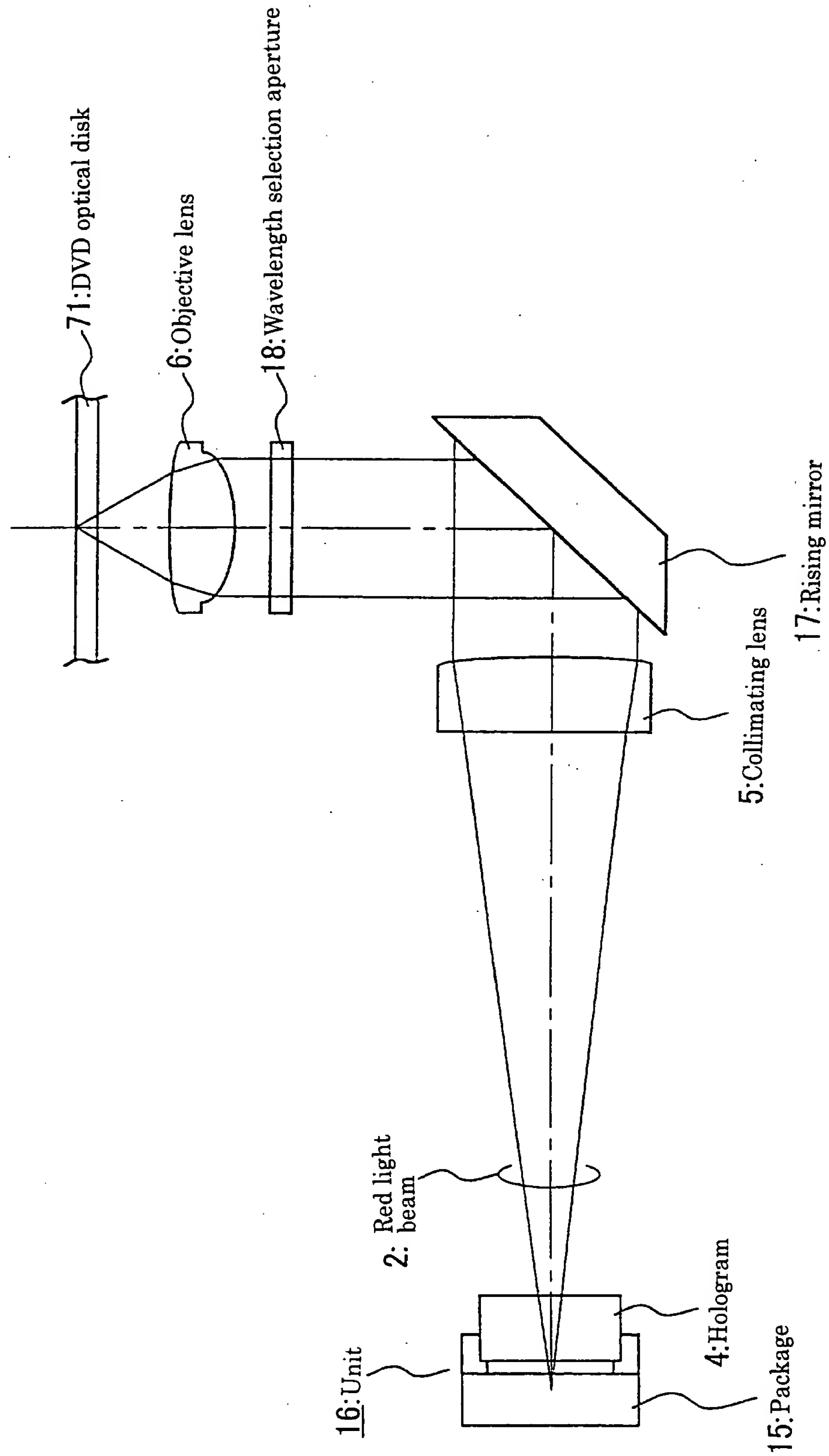
[Fig. 3]


72:CD optical disk
6:Objective lens
20 : Optical pick-up
5:Collimating lens
4:Hologram
3: Grating
12: +First-order diffracted light
13: −First-order diffracted light
83: Photo detecting portion (PD2)
81: Photo detecting portion (PD0)
82: Photo detecting portion (PD1)
1a:Red laser
25: Infrared light beam
1b: Infrared laser
d2
d2

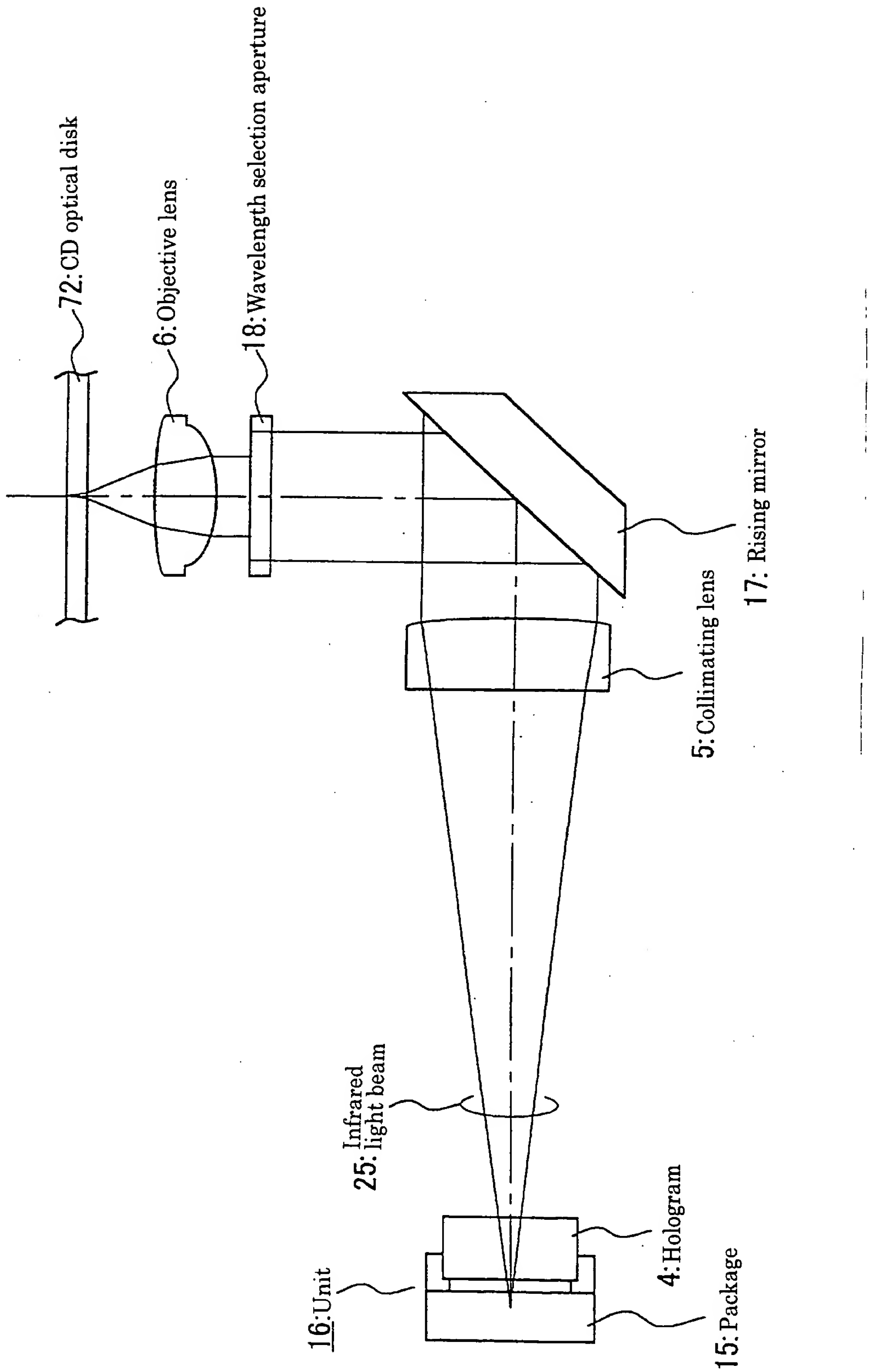
[Fig. 4]


Width of convex portion
Width of concave portion
h
3 : Grating

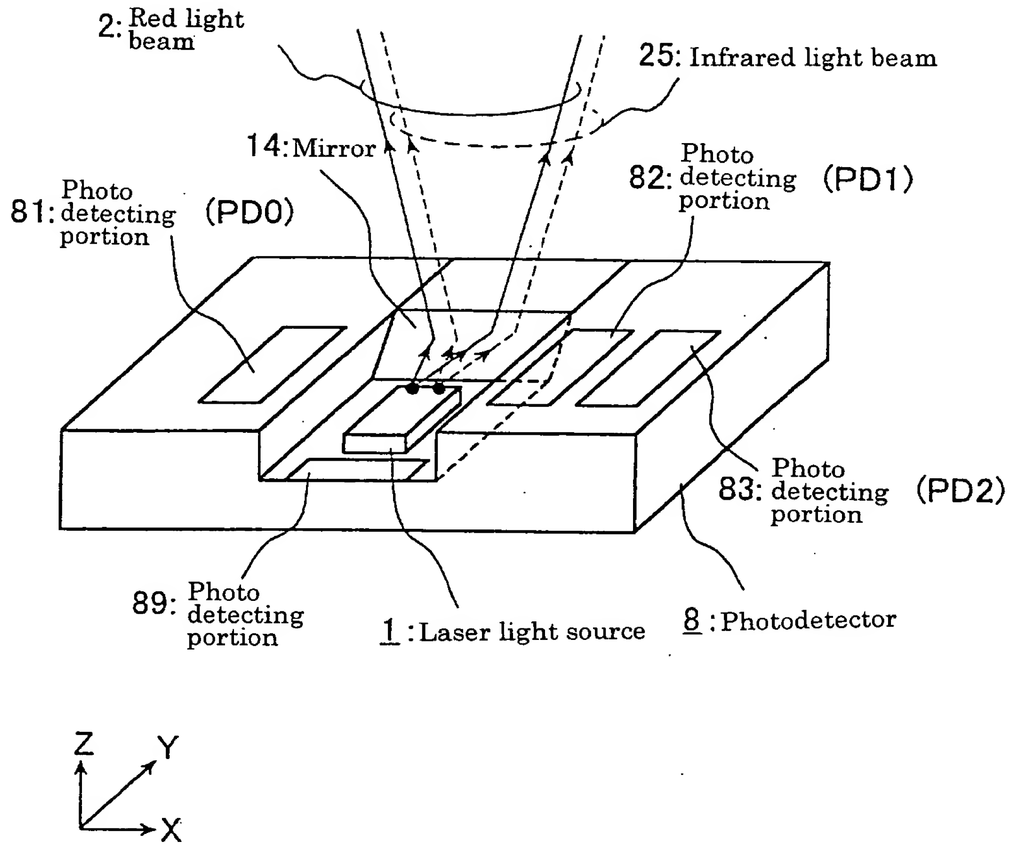
[Fig. 5]


71:DVD optical disk
6:Objective lens
18:Wavelength selection aperture
17:Rising mirror
5:Collimating lens
2: Red light beam
4:Hologram
16:Unit
15:Package

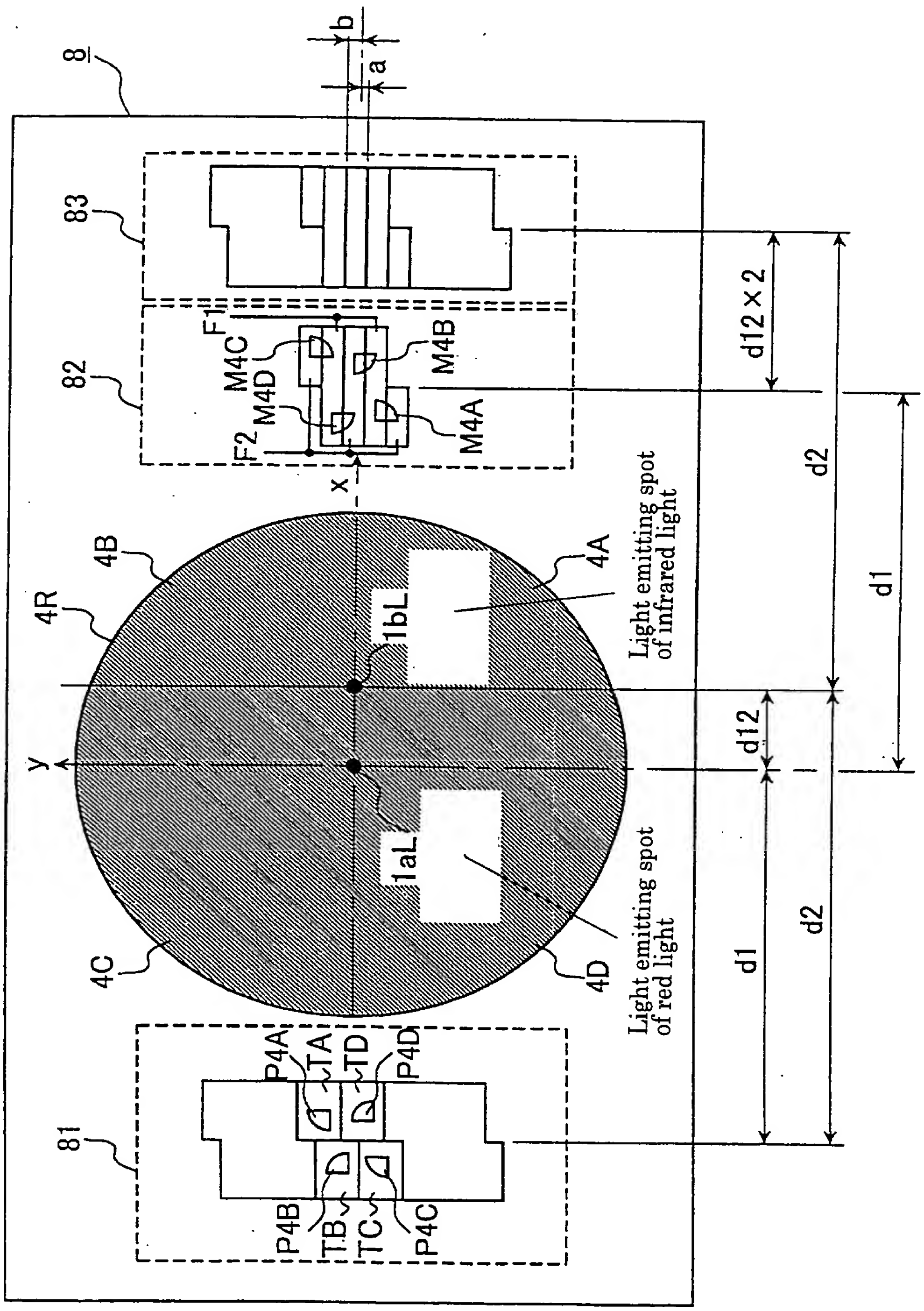
[Fig. 6]


72:CD optical disk
6:Objective lens
18:Wavelength selection aperture
17: Rising mirror
5:Collimating lens
25: Infrared light beam
4:Hologram
16:Unit
15:Package

[Fig. 7]

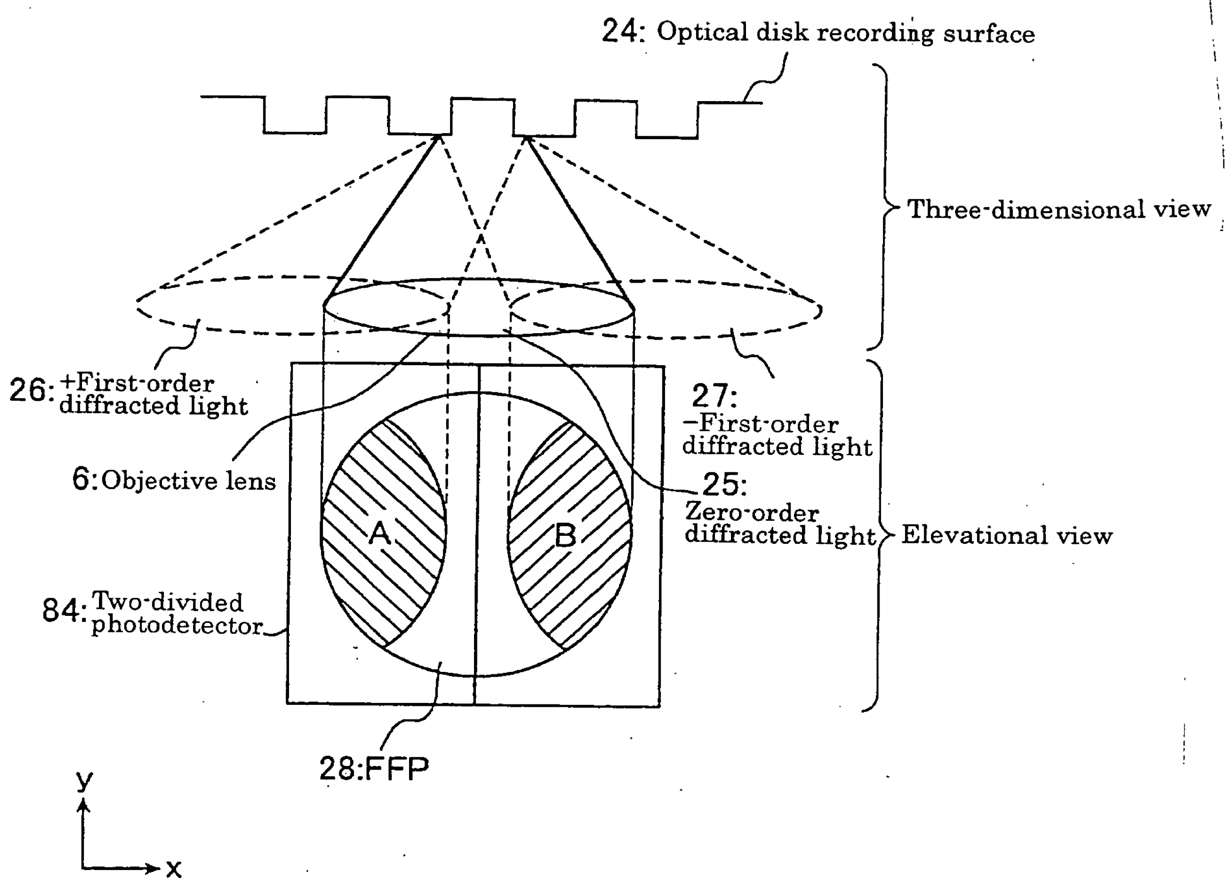

2: Red light beam
25: Infrared light beam
14: Mirror
82: Photo detecting portion (PD1)
81: Photo detecting portion (PD0)
83: Photo detecting portion (PD2)
89: Photo detecting portion
1 : Laser light source
8 : Photodetector
Z
Y
X

[Fig. 8]

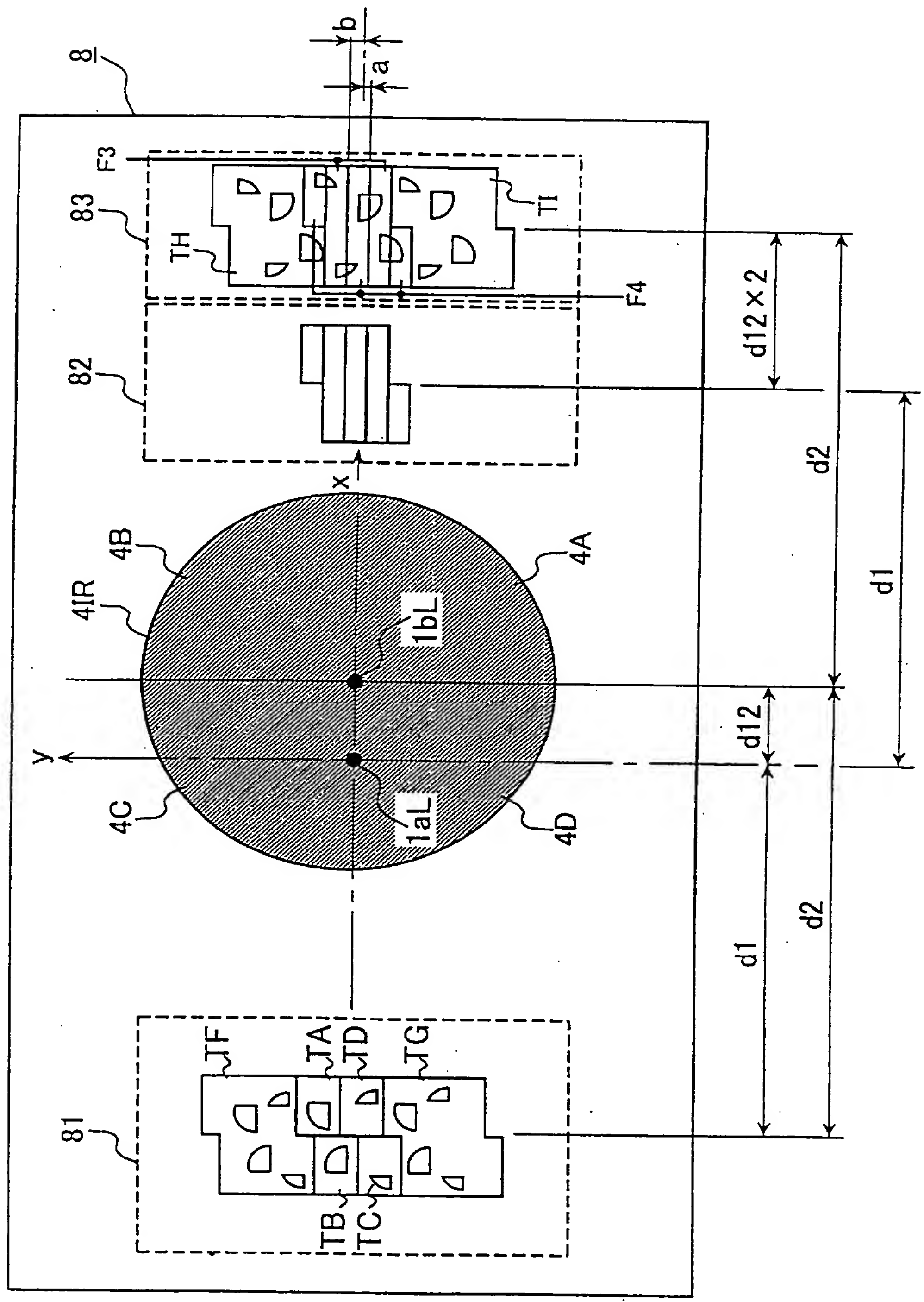


8
81
82
83
4R
4A
4B
4C
4D
1aL
1bL
x
y
a
b
F1
F2
M4A
M4B
M4C
M4D
P4A
P4B
P4C
P4D
TA
TB
TC
TD
d1
d2
d12
d12×2
Light emitting spot of infrared light
Light emitting spot of red light

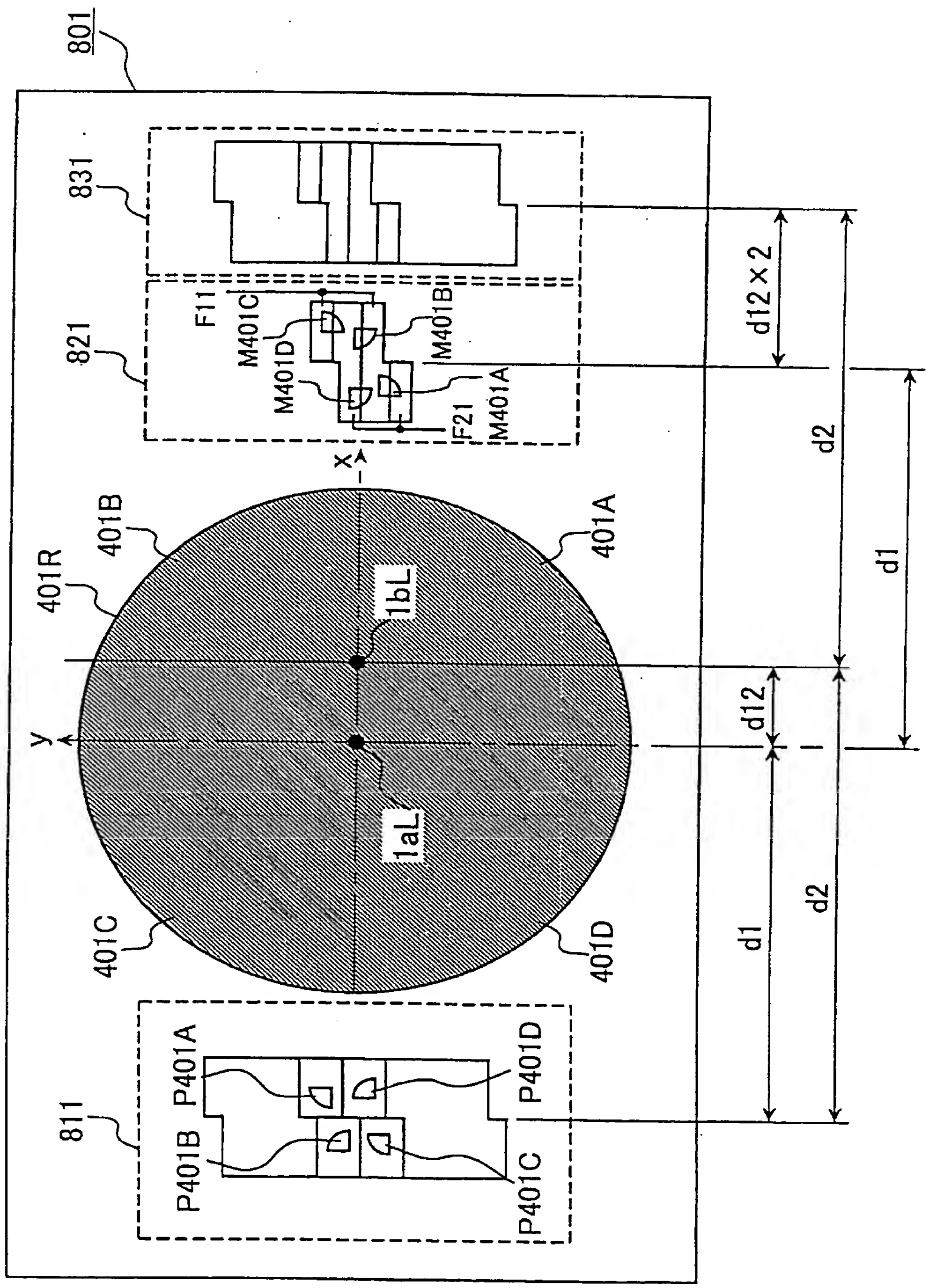
[Fig. 9]


24: Optical disk recording surface
Three-dimensional view
26: +First-order diffracted light
27: −First-order diffracted light
6: Objective lens
25: Zero-order diffracted light
Elevational view
A
B
84: Two-divided photodetector
28:FFP
y
x

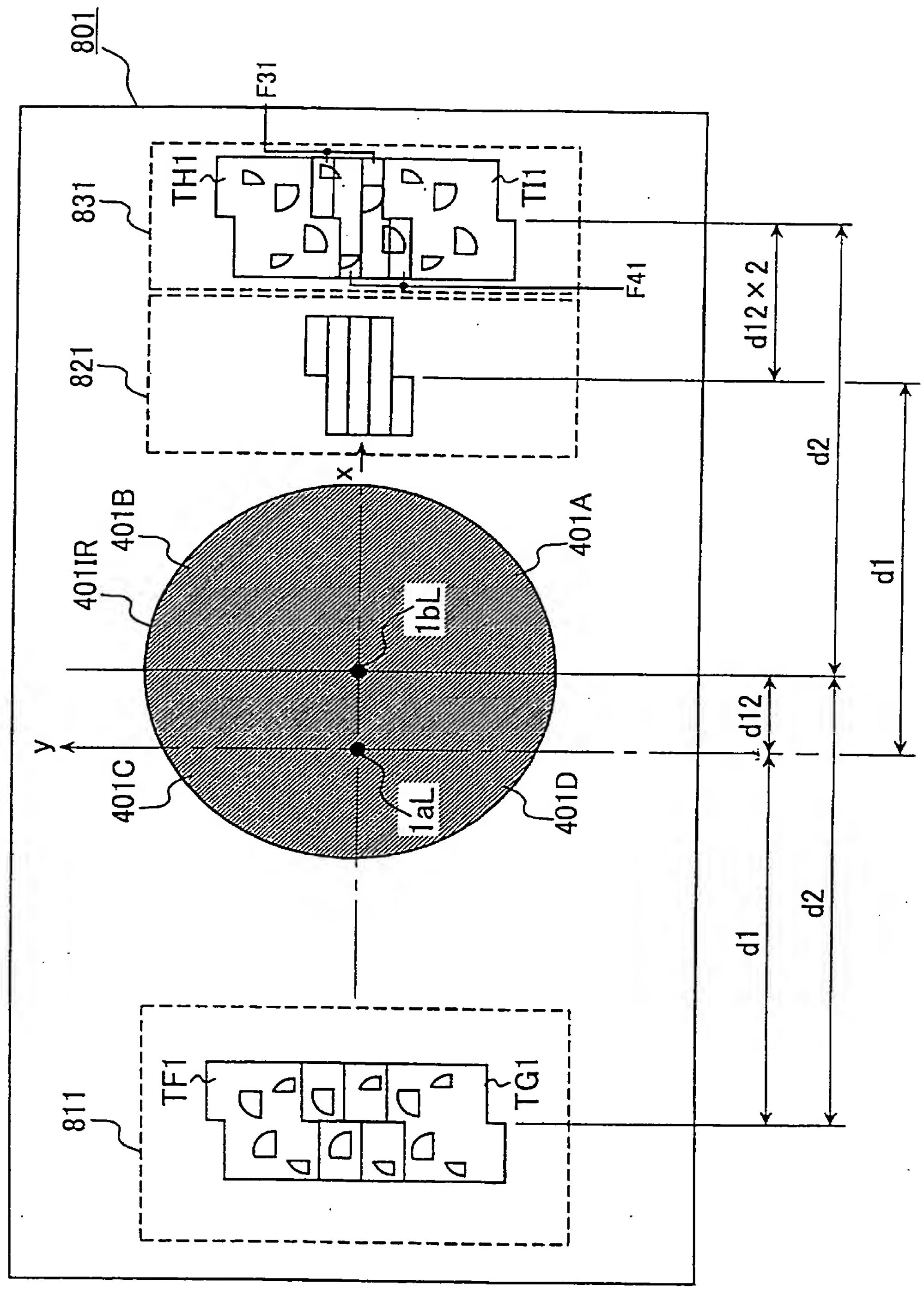
[Fig. 10]


8
a
b
F3
F4
83
TH
TI
82
d12×2
d2
d1
x
y
4B
4IR
4A
1bL
1aL
4C
4D
d12
81
TF
TA
TD
TG
TB
TC

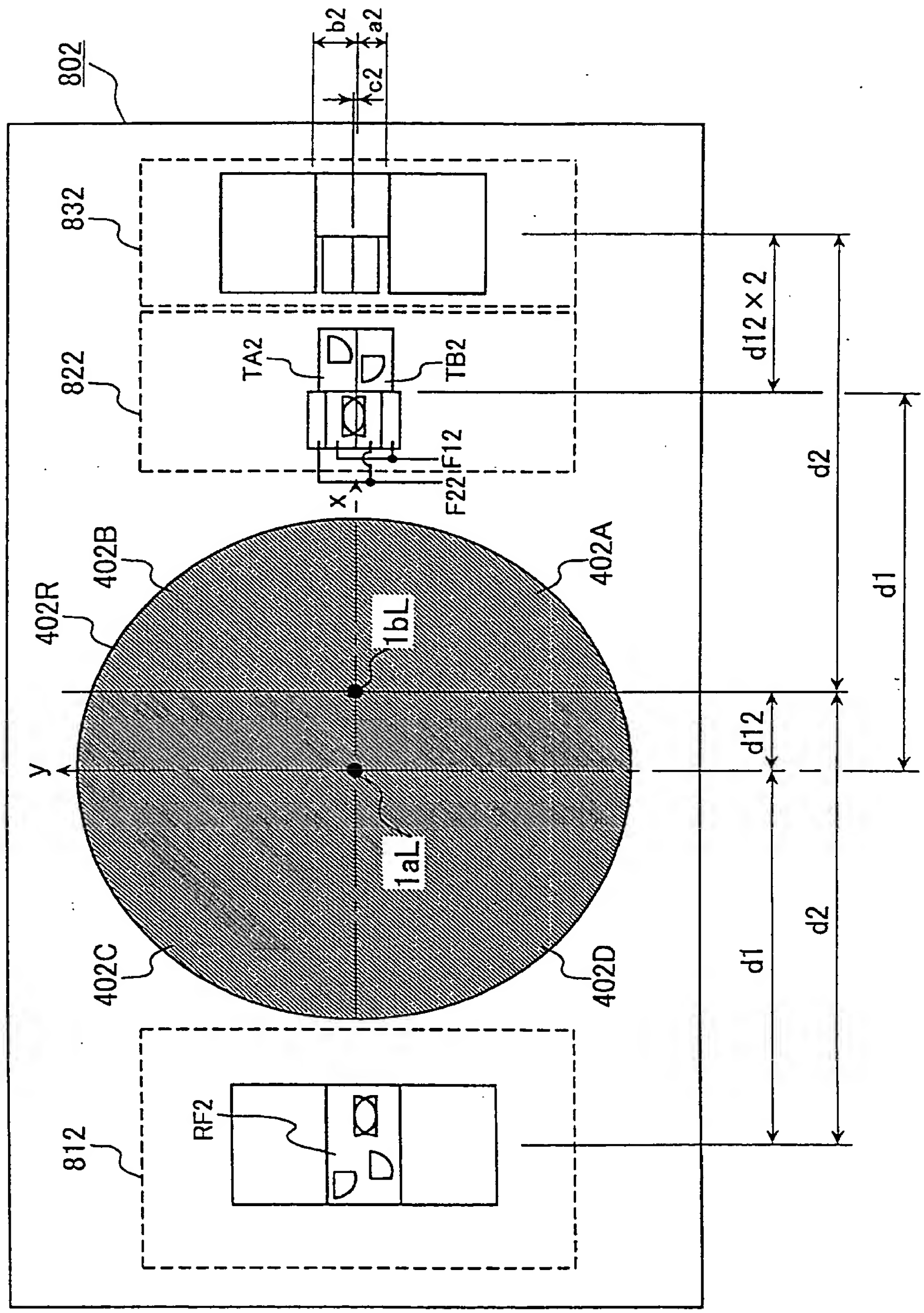
[Fig. 11]


801
831
821
F11
M401C
M401D
M401B
M401A
F21
x
y
401R
401B
401A
1bL
1aL
401C
401D
811
P401A
P401B
P401C
P401D
d12×2
d2
d1
d12
d1
d2

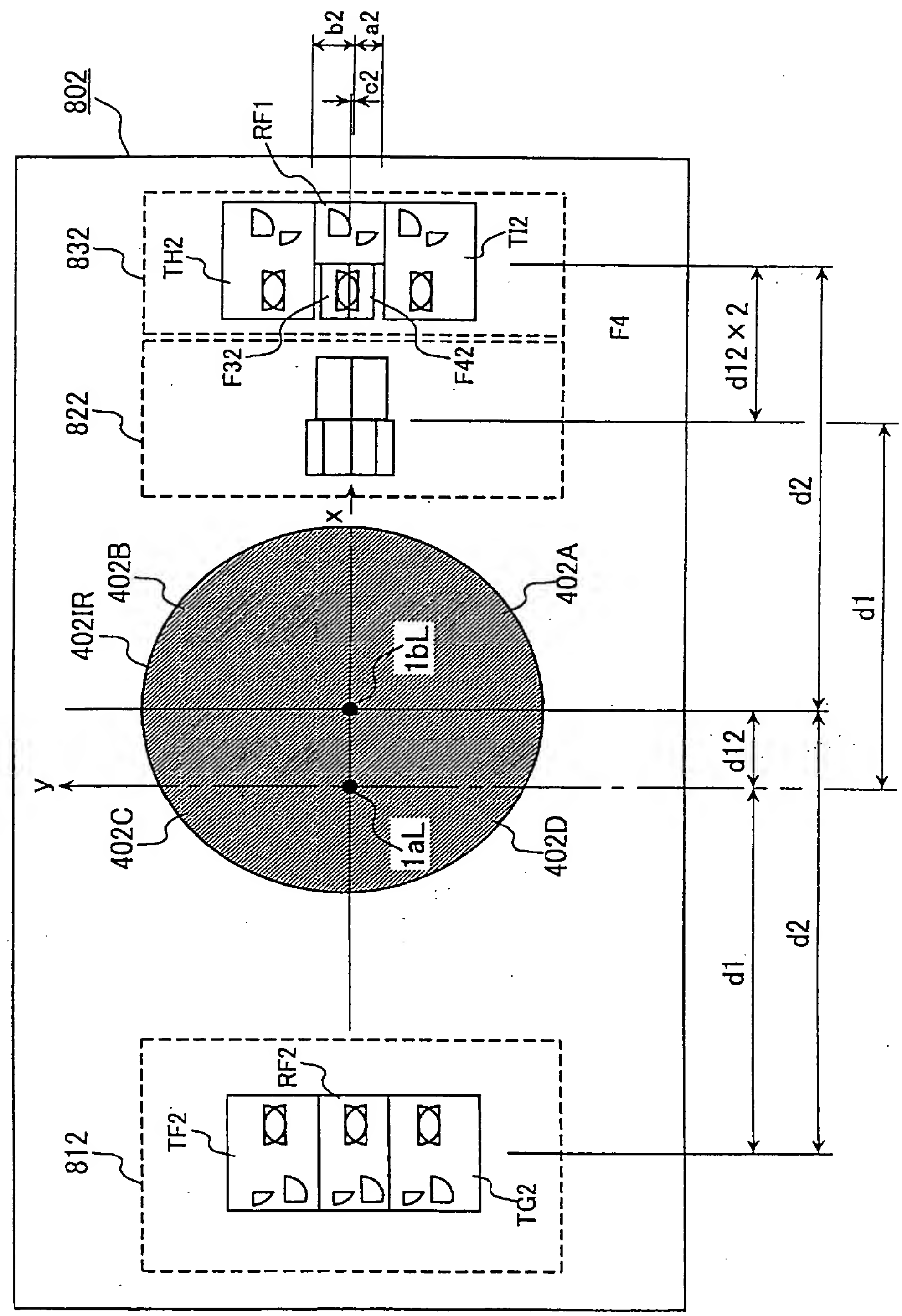
[Fig. 12]


801
831
821
811
F31
F41
TH1
TI1
TF1
TG1
401IR
401B
401A
401C
401D
1bL
1aL
x
y
d12×2
d2
d1
d12
d1
d2

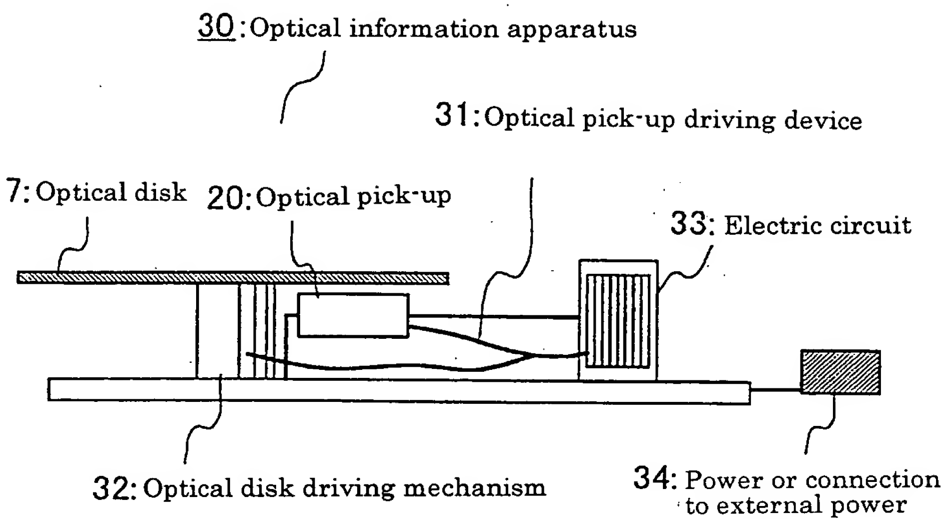
[Fig. 13]


802
832
822
812
b2
a2
c2
TA2
TB2
F12
F22
x
y
402R
402B
402A
402C
402D
1bL
1aL
RF2
d12×2
d2
d1
d12
d1
d2

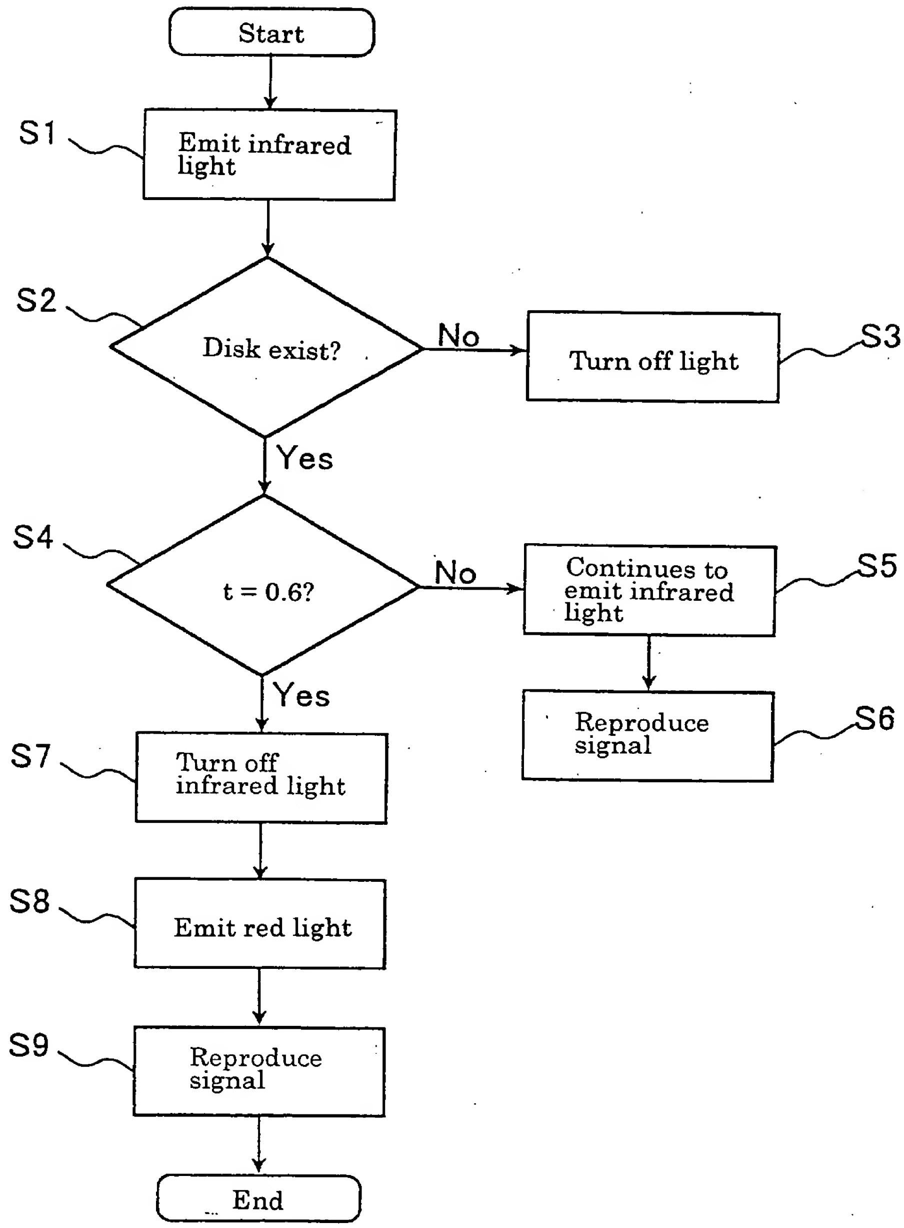
[Fig. 14]


802
b2
a2
c2
RF1
832
TH2
TI2
F32
F42
F4
822
d12×2
d2
d1
x
y
402B
402A
402IR
1bL
1aL
402C
402D
d12
812
TF2
RF2
TG2

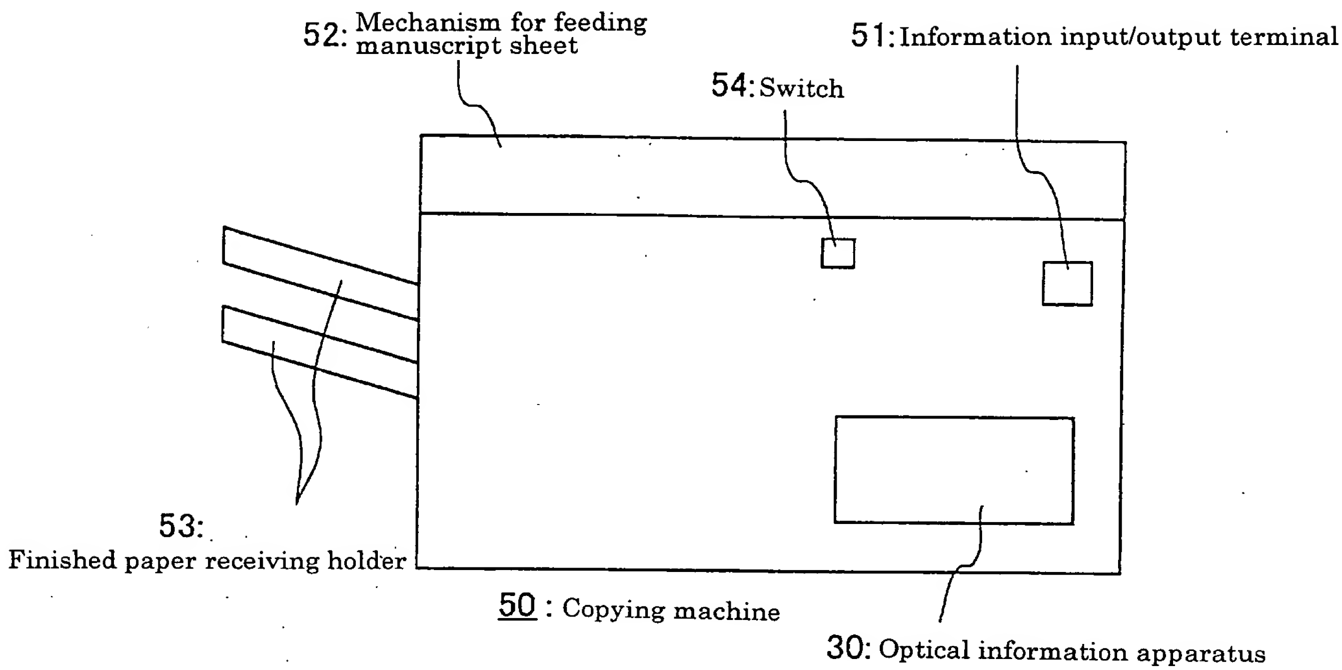
[Fig. 15]


30:Optical information apparatus
31:Optical pick-up driving device
7:Optical disk
20:Optical pick-up
33: Electric circuit
32: Optical disk driving mechanism
34: Power or connection
to external power

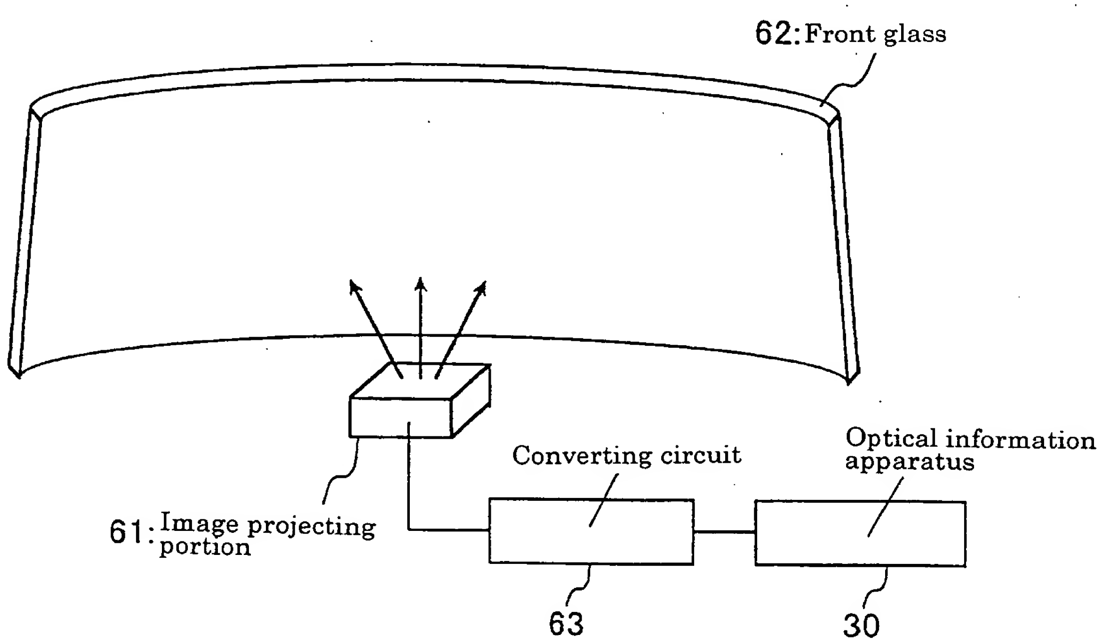
[Fig. 16]


Start
S1
Emit infrared light
S2
Disk exist?
No
Turn off light
S3
Yes
S4
t = 0.6?
No
Continues to emit infrared light
S5
Reproduce signal
S6
Yes
S7
Turn off infrared light
S8
Emit red light
S9
Reproduce signal
End

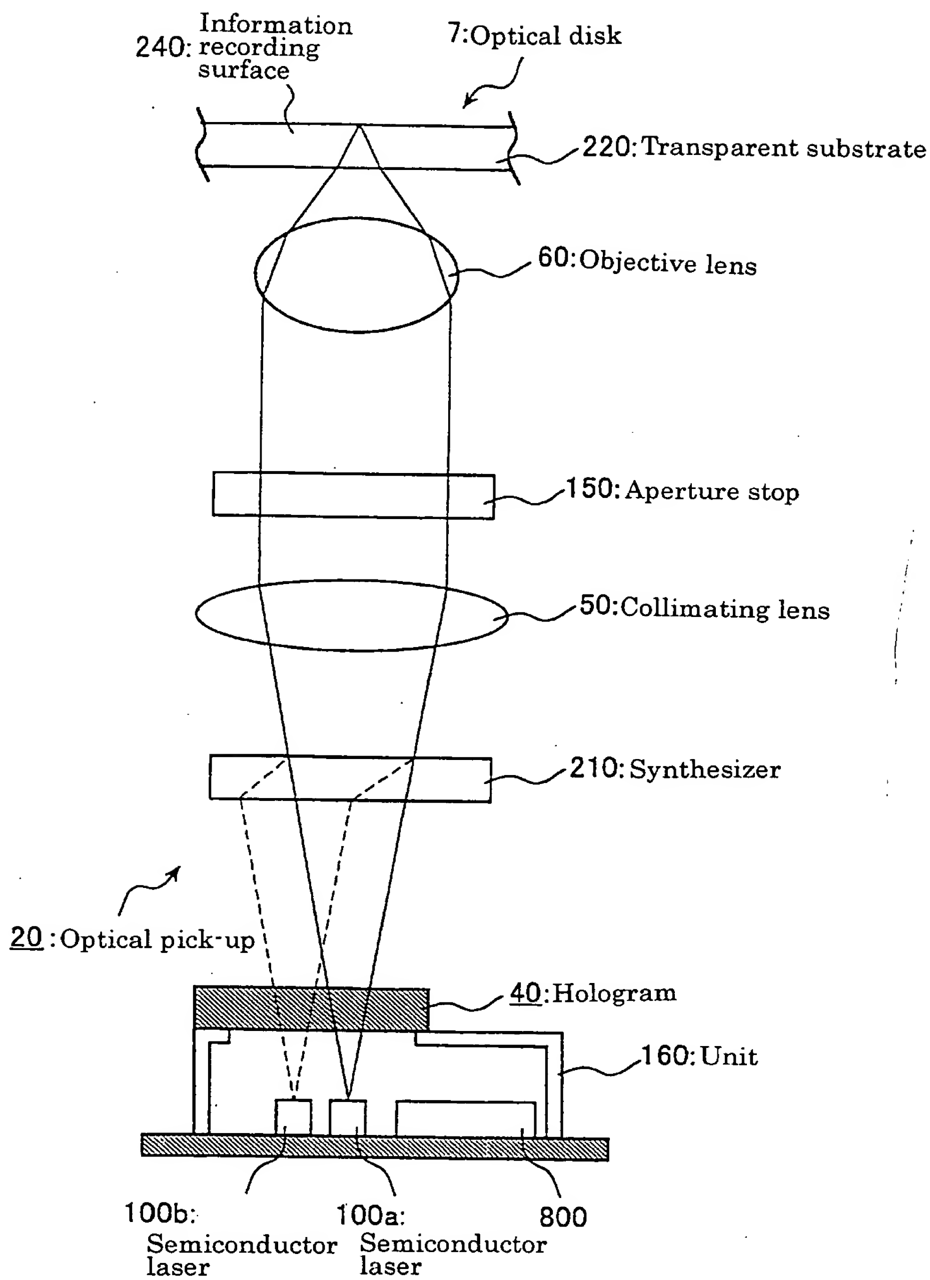
[Fig. 17]


52: Mechanism for feeding manuscript sheet
51: Information input/output terminal
54: Switch
53: Finished paper receiving holder
50 : Copying machine
30: Optical information apparatus

[Fig. 18]

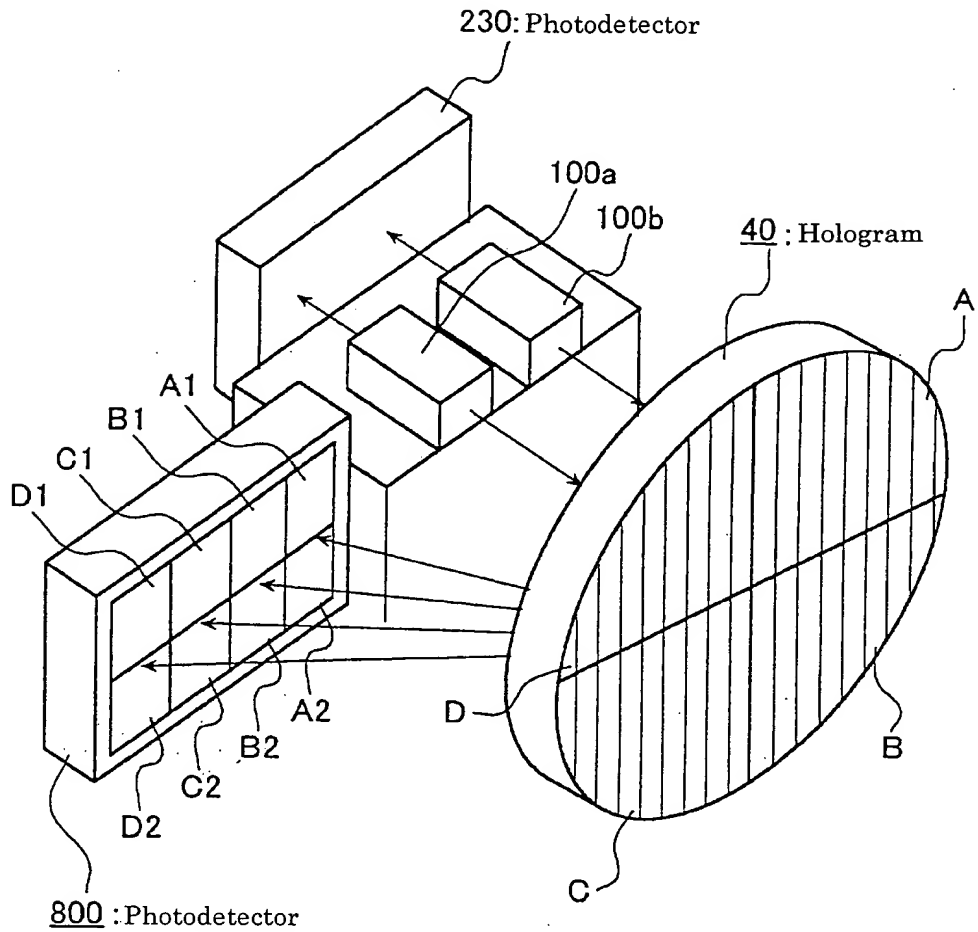

62: Front glass
Converting circuit
Optical information apparatus
61: Image projecting portion
63
30

[Fig. 19]



240: Information recording surface
7:Optical disk
220:Transparent substrate
60:Objective lens
150:Aperture stop
50:Collimating lens
210:Synthesizer
20 :Optical pick-up
40:Hologram
160:Unit
100b: Semiconductor laser
100a: Semiconductor laser
800

[Fig. 20]


230: Photodetector
100a
100b
40 : Hologram
A
A1
B1
C1
D1
A2
B2
C2
D2
D
B
C
800 : Photodetector

[Name of the Document] ABSTRACT

[Abstract]

[Objective] To provide an optical pick-up capable of reproducing information excellently on both CD and DVD, which are significantly different in terms of three kinds of factors, a base material thickness, a wavelength of a light source, and NA, and detecting TE signals by three kinds of methods, that is, the phase difference method, the PP method, and the 3-beam method, which are necessary to record and reproduce information.

[Means for solving the problem] The optical pick-up is formed by integrating laser light sources 1a and 1b having two kinds of wavelengths ($\lambda 1$, $\lambda 2$) for detecting TE signals, photodetectors 81, 82 and 83, and a hologram 4 for generating the diffracted light for detecting signals. The distance d1 between the center of the photo detecting portion PD081 and the light emitting spot of the first laser light source and a distance d2 between the center of the photo detecting portion PD081 and the light emitting spot of the second laser light source satisfy the following relationship: $\lambda 1/\lambda 2 \fallingdotseq d1/d2$.

[Selected Figure] Fig. 1